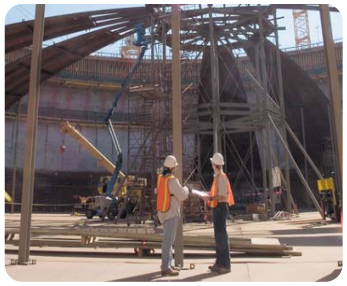
BUILDING A WORLD OF DIFFERENCE®

BLACK & VEATCH





Renewable Energy Transmission Initiative Phase 1B Draft Resource Report

Black & Veatch

Plenary Stakeholder Group Meeting

August 20, 2008

Introductions

Ryan Pletka

Tim Mason

Ric O'Connell

Today's Objective

Review the highlights of the Phase 1B *Draft* Resource Report with the Plenary Stakeholder Group

Agenda

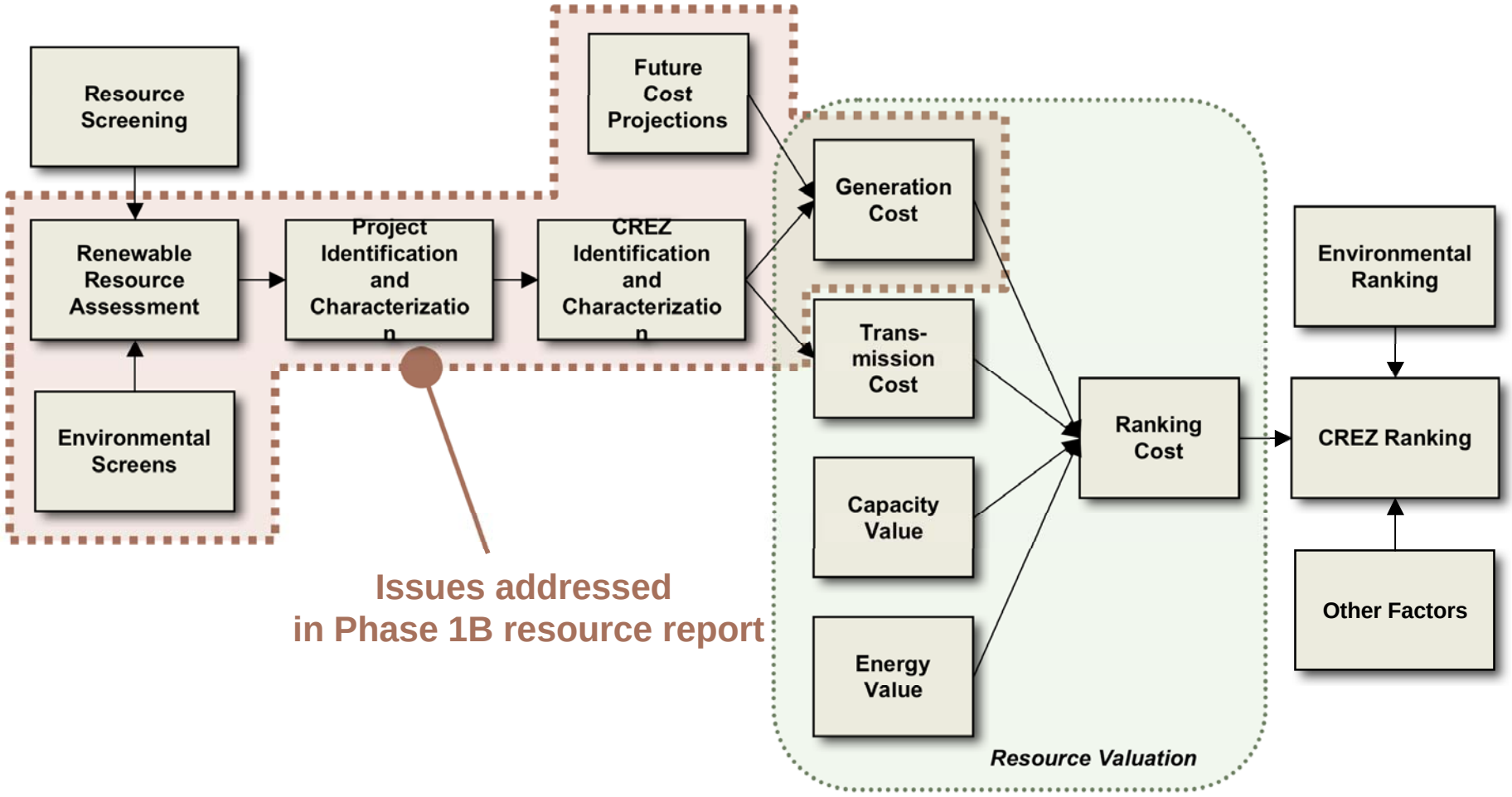
- Introduction / Overview
- Project Identification Process
- Project Identification and Characterization
  - Biomass
  - Geothermal
  - Solar Thermal
  - Solar Photovoltaic
  - Wind
- CREZ Identification
- Next Steps

Introduction

RETI Phase 1

- Objective: Identify Competitive Renewable Energy Zones
- Phase 1A:
  - Assumptions
  - Methodology
  - Resource screening for Phase 1B
- Phase 1B:
  - Project & CREZ identification and characterization

Overview of RETI 1A Process



Purpose of the Draft 1B Resource Report is to allow for stakeholder feedback prior to completing the evaluation.

Phase 1B Draft Resources Report – August 16

- Executive Summary
- Introduction
- Methodology and Assumptions
- Biomass
- Geothermal
- Solar Photovoltaic
- Solar Thermal
- Wind
- Competitive Renewable Energy Zones

available at www.energy.ca.gov/reti

Phase 1B Draft Maps

- Resource Exclusion Maps
  - General resource exclusions
  - Solar PV resource exclusions
  - Solar thermal resource exclusions
  - Wind resource exclusions
- CREZ/Resource Region Maps
  - Competitive Renewable Energy Zones
  - Resource regions
- Project Identification Maps
  - Biomass
  - Geothermal
  - Solar PV
  - Solar thermal
  - Wind

available at www.energy.ca.gov/reti

Known Report Corrections to be Addressed in Final Report

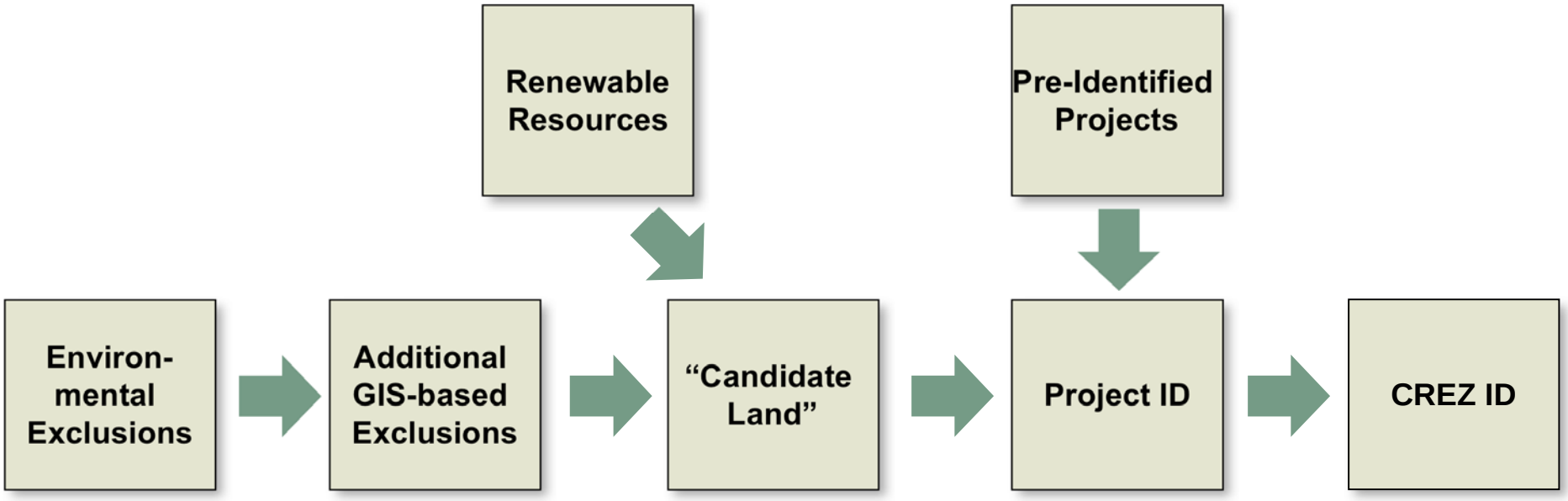
- Add pre-identified projects (discussed later)
- Wind: References to 6.3 m/sec as the wind filter should be changed to 6.7 m/sec
- Wind maps: labels on some projects are incorrect. Correct values will be generally lower
- Wind: Table 3-3 is missing 74 MW Vandenberg Air Force Base
- Solar PV maps: Some maps incorrectly show large PV projects as 200 MW. Should be 150 MW.
- Geothermal: Table 3-10 British Columbia resources are incorrect. Table 5-2 has correct values
- Geothermal: Table 5-2 O&M costs are off by one row. LCOE values are correct, however.
- Geothermal: Table 5-1, Nevada resource should be listed as 1450 MW

Project Identification Process

List of Screened Resources from Phase 1A

Resource Recommendations for Phase 1B.							
	CA	OR	WA	NV	AZ	Baja California, MX	British Columbia, CA
Solid Biomass	✓	✓	✓				✓
Solar Photovoltaic	✓						
Solar Thermal	✓			✓ (south)	✓ (west)		
Small Hydro	✓	✓	✓				✓
Onshore Wind	✓	✓	✓	✓ (south)		✓ (north)	✓
Geothermal	✓	✓		✓			✓

Generalized Project / CREZ Identification Process (Applies to almost everything)



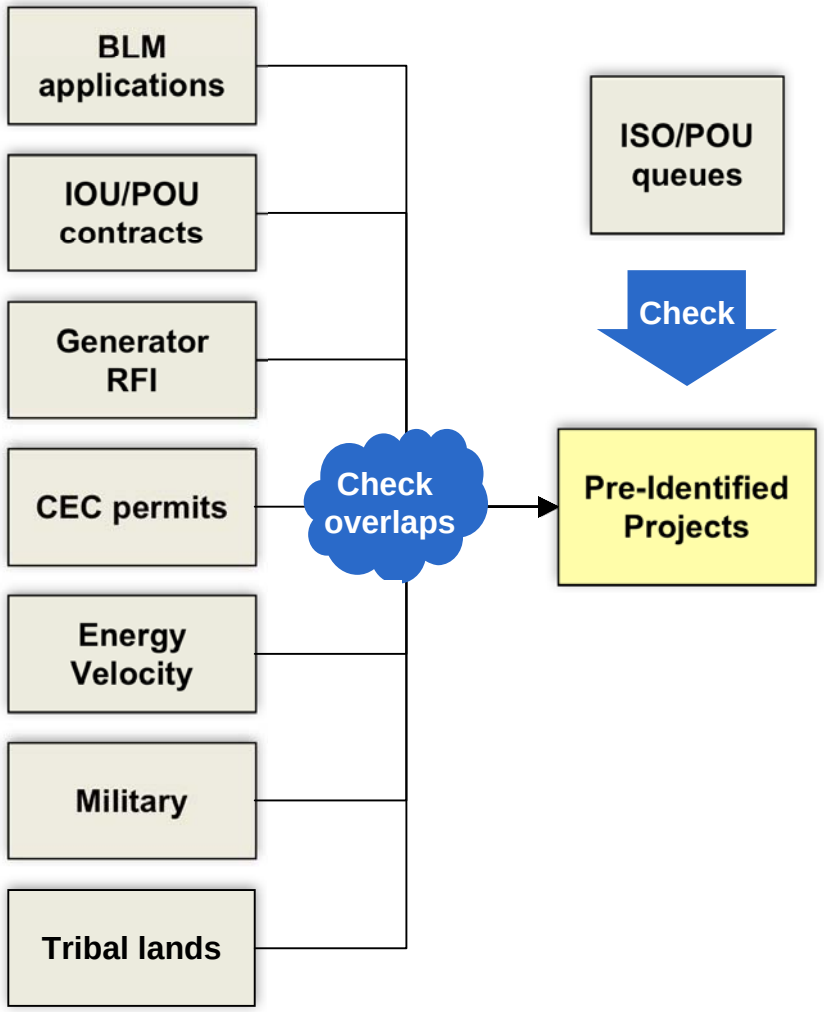
Project Identification and Characterization

Generation Projects

- **Pre-Identified Projects** – Areas/regions with some commercial interest or designation
  - Allows placement in otherwise restricted areas
  - Potential timing advantage
- **Proxy Projects** – All other projects identified by Black & Veatch
  - Avoid restricted areas
  - Default timing assumptions

Pre-Identified Projects: Sources

- Collect project data
  - BLM applications, IOU/POU contracts, Generator RFI, CEC Permits, Energy Velocity, Military, Tribal
  - Check for overlaps
- Check against ISO/POU queues by county
  - Projects should exceed ISO/POU queue totals for each county
  - Gaps will be filled with proxy projects

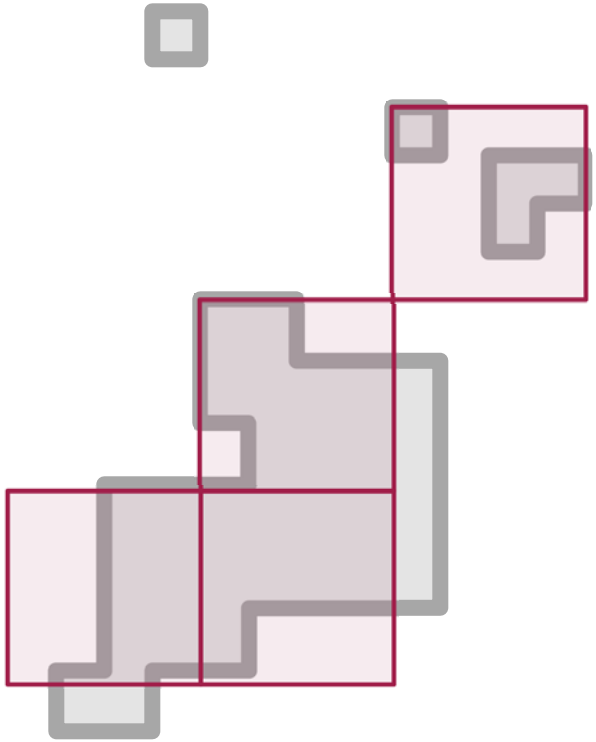


Summary of Pre-Identified Projects

	Biomass		Geothermal		Solar PV		Solar Thermal		Wind	
	No. Proj.	**MW**	**No. Proj.**	**MW**	**No. Proj.**	**MW**	**No. Proj**	**MW**	**No. Proj.**	**MW**
PPAs	12	125	9	379	4	15	11	2,129	28	2,903
BLM Apps.	0	0	0	0	32	20,625	100	74,588	144	642
RFIs	1	11	15	1,972	1	52	18	10,340	35	11,421
Military	0	0	1	100	0	0	6	586	0	0
TOTAL	**13**	**136**	**25**	**2,451**	**37**	**20,692**	**135**	**87,643**	**207**	**14,324**

Using Pre-Identified Projects

- Due to data quality and other issues, boundaries of pre-identified projects are not directly loaded in model
- Represented with analogous project boundaries
- Goal of characterization is not to simulate specific projects, but broad resource areas (CREZs)



Resource Exclusions

	Geo-thermal	Solar PV	Solar Thermal	Wind	Notes
Environmental black areas	Yes	Yes	Yes	Yes	
Environmental yellow areas	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Wetlands and water bodies	Yes	Yes	Yes	Yes	Dry lakes not excluded
Native American reservations	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Military lands	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Mines (surface)	Yes	Yes	Yes	Yes	
Urban areas	Yes	Yes, +buffer	Yes, +buffer	Yes, +buffer	buffer up to 3 miles depending on pop.
Airports	Yes	Yes	Yes	Yes, +buffer	Major airports only. Wind buffer up to 5 mi
Military flyways	No	No	No	Yes* (Red)	*Pre-ID projects OK in red zones. All other open.
Williamson Act Prime Ag Land	No	Yes*	Yes*	No	*Pre-identified projects OK
Williamson Act Non-Prime Ag Land	No	Yes**	Yes**	No	**Excluded until 2018, pre-ID projects OK
Renewable resource quality	No	No	< 6 kWh/ m^2/day	< 6.7 m/sec	
Min. contiguous square acreage	No	160	1280	none	640 acres = 1 section = 1 square mile
Land slope	No	> 5%	> 2%	> 20%	Geothermal evaluated case by case
Note: Because biomass plants have very high siting flexibility, explicit land exclusions were not applied. Biomass plants can be easily moved to avoid sensitive areas.					

Biomass

Biomass - Methodology

- California Biomass Collaborative (CBC) 2010 technically feasible capacity by county as basis for supply
- Determined potential MW from supply using 80% capacity factor, 13,650 BTU/kWh heat rate, and CBC energy content per feedstock
  - Reduced by assuming 1/3rd of supply available for power generation (remainder for other purposes or potentially too expensive)
  - Minimum project size set at 20 MW for economic feasibility
  - Identified single and multi-county projects; sited near existing substations and as close as possible to resource (reduces need for new transmission)
- Environmental cost (NOx and PM) included based on location and ERC costs per AQMD or APCD. Lead to relocation of 8 projects due to high ERC cost (SCAQMD and SJVAPCD)

Biomass – Characterization Assumptions

- Stoker or fluidized bed steam generator
- Feedstock costs based on data from stakeholders, from $24 to 48 per dry ton (average $40)
- Capital cost: $4000 to $5500/kW
  - Higher than 1A due to smaller plant sizes and recent escalation
- Fixed and Variable O&M Costs: Varied from $56 to $116/kW-yr (fixed) and $10.3 to $13.6/MWh (variable)
- Heat Rate: 14,000 BTU/kWh to 15,780 BTU/kWh, depending on fuel moisture content
- Capacity Factor: 80 percent

Biomass - Results

- California
  - 46 projects, 1,725 MW, ~12,000 GWh
  - Generation cost (with transmission and gen tie) = $114 to $190/MWh (avg. $158)
- Oregon and Washington
  - 29 projects, 904 MW
  - Will assumine only half of generation available to CA (~3,150 GWh)
- British Columbia
  - 1,520 MW total generation capacity identified by PG&E

Biomass - Siting

- Plants located largely north of Kern County (37 of 46)
- Urban wood waste least cost LCOE
- Agricultural residues high cost due to size and location in areas of poor air quality
- Location near existing substations limits the amount of transmission upgrade needed

- All biomass projects are proxy projects.
- California projects are deliberately sited, out of state potential represented by projects placed at the center of counties.

Geothermal

Project Identification and Characterization – Geothermal

- Sites based on specific tracts with enough public information to make quantitative estimate of MW potential over a development horizon of about 10 years
- Data sources include:
  - Existing plants with expansion potential
  - Known Geothermal Resource Areas (KGRAs)
  - Geothermal leases
  - Prospect areas identified by published MW assessments
  - Industry publications and technical articles
  - Developer responses to RETI survey

Project Identification and Characterization – Geothermal

Proxy Projects

- Proxy project approach not used for geothermal
- Only areas in which assessment work or leasing has already occurred were considered relevant for transmission planning over 10-year horizon

Out of State Projects

- Considered projects in Nevada, Oregon, and southern British Columbia
- Account for over half of identified potential (2,199 out of 4,172 net MW)

Project Identification and Characterization – Geothermal

Capital Costs

- Estimates based on recent industry experience
- Comparison to cost estimates of CEC-PIER report (2004):
  - Escalation by about 20% from 2004 to 2008
  - Smaller projects generally higher costs per kW installed
- Correlation of capital cost vs size used to estimate costs for projects not considered by CEC-PIER report
- Capital cost estimates $3,750 - $6,750 per kW (net)
  - Leaves off most expensive 10% of estimated MW capacity

Project Identification and Characterization – Geothermal

O&M Costs

- Includes site costs, G&A, workovers, royalties, and insurance
- Does not include ongoing capital expenditures (such as make-up drilling)
- Smaller projects generally higher costs per kWh
- O&M ranges from $24 to $38 per MWh (net)

Project Identification and Characterization – Geothermal

Results

- Identified 115 sites with potential for incremental MW
  - 12 sites in California (1,958 MW net)
    - 5 sites in Imperial Valley (1,434 MW net)
  - 81 sites in Nevada (1,450 MW net)
  - 15 sites in Oregon (520 MW net)
  - 7 sites in southern British Columbia (244 MW net)
- Total: 4,172 MW net
- Cost of generation for most projects: $70-130/MWh.

Solar Thermal

Project Identification and Characterization – Solar Thermal

- Solar resource is more uniform and more widely available than other renewable resources
  - Possible to identify more potential projects than are necessary or feasible
- Approach is to identify potential projects in all promising candidate areas
  - Economic and environmental analysis will select the best for inclusion in CREZ analysis

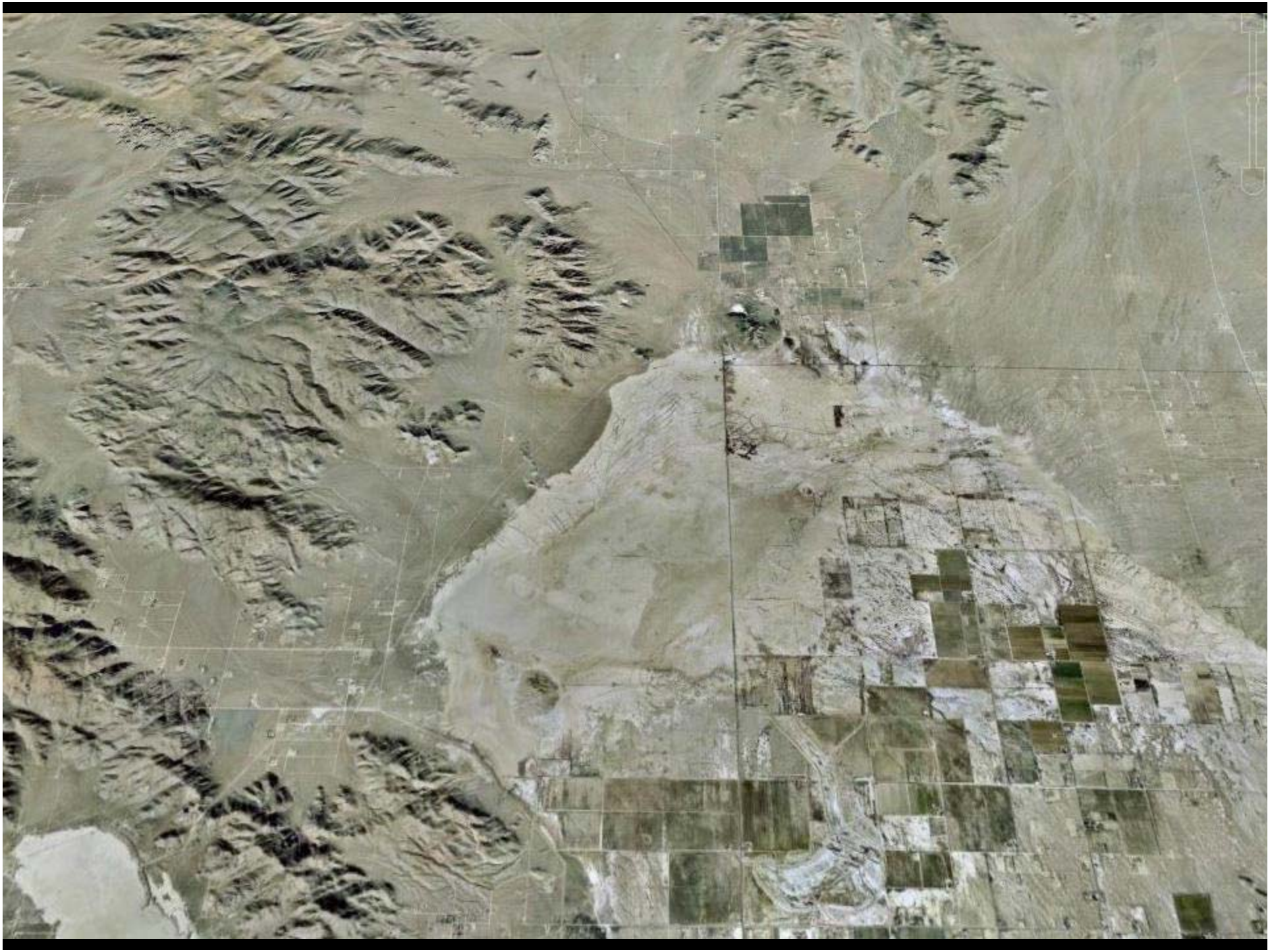
Project Identification and Characterization – Solar Thermal

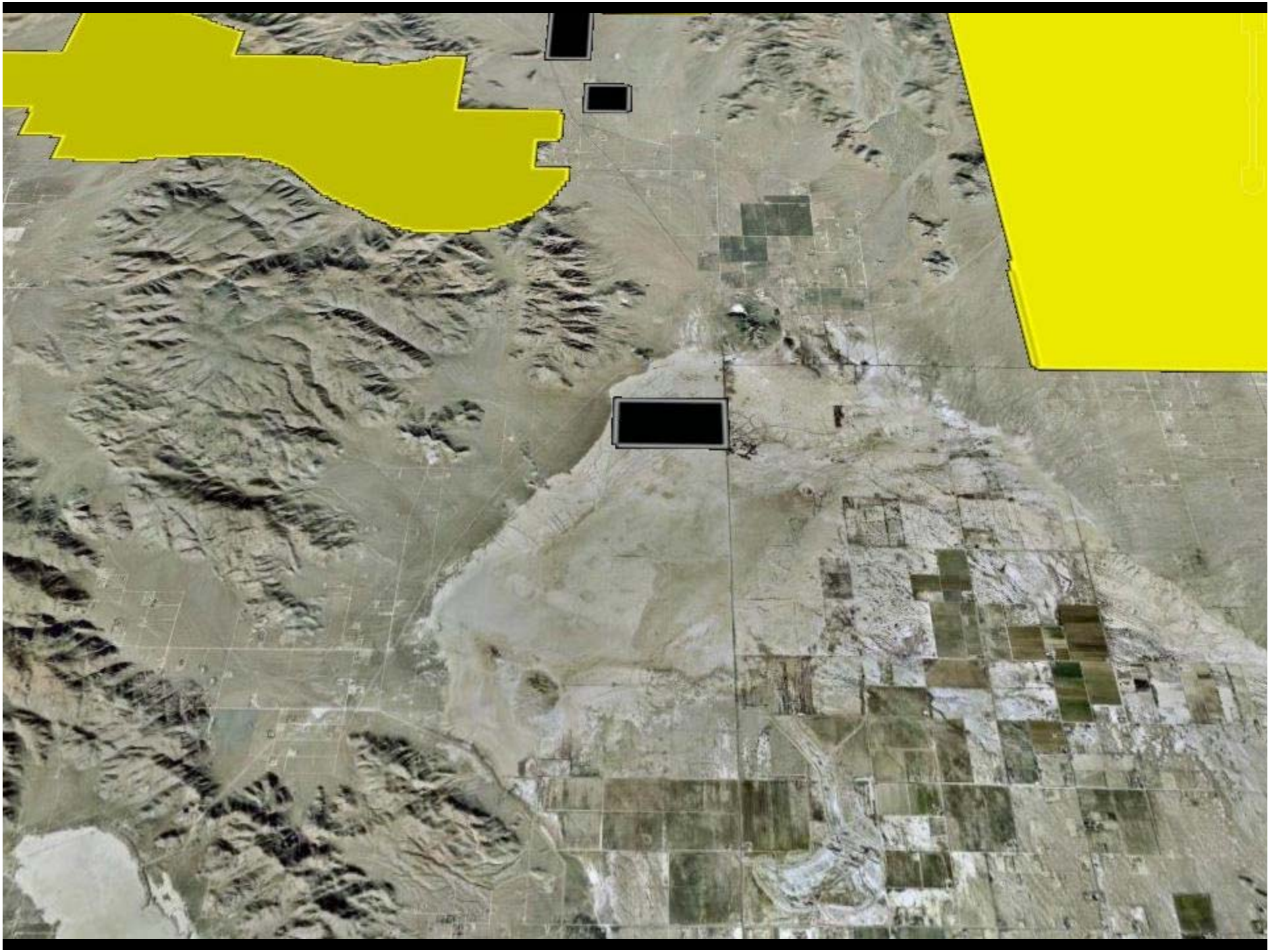
Proxy Projects

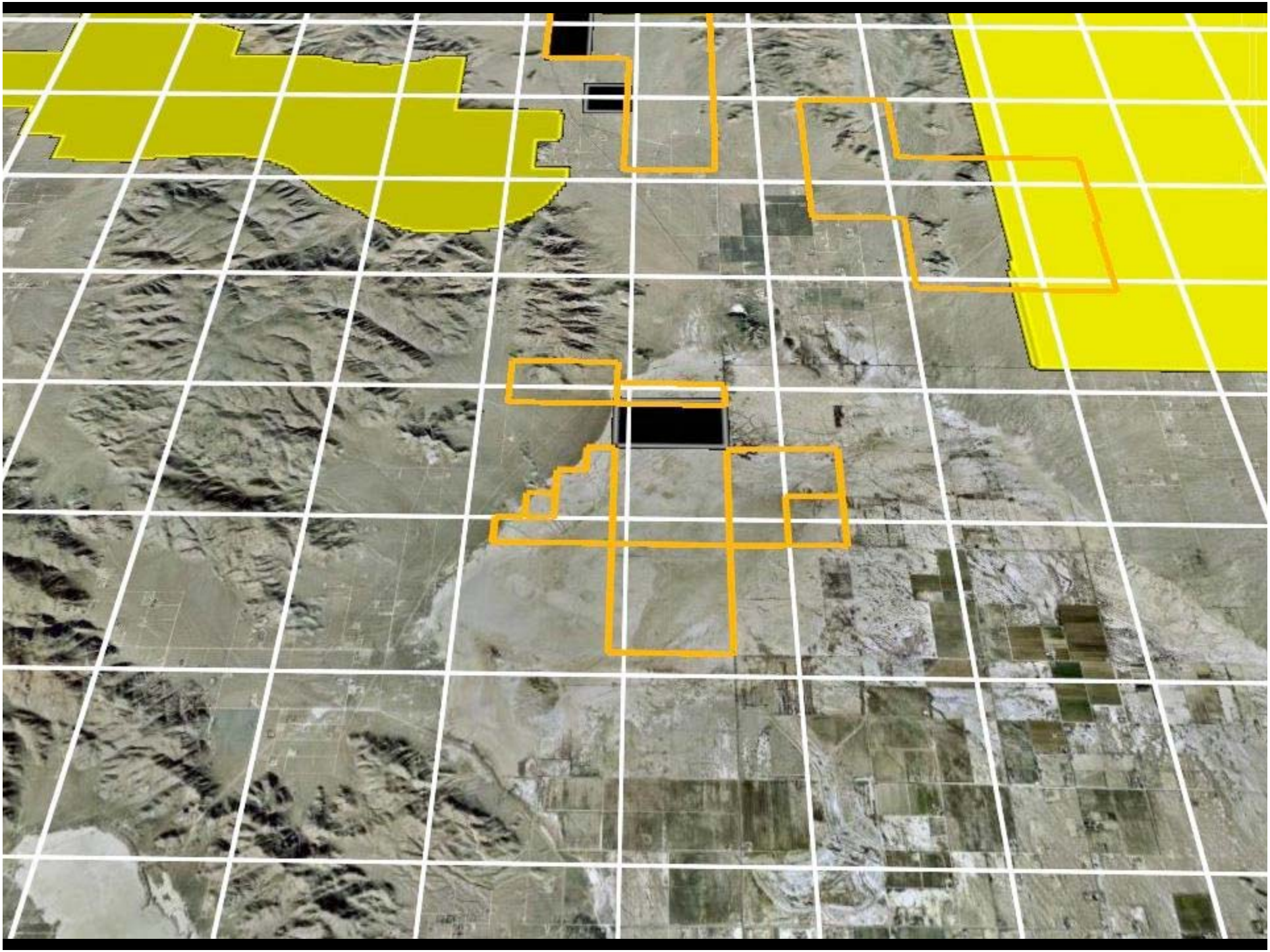
- 200 MW proxy projects developed in California as necessary to populate the analysis
  - Located on environmentally appropriate parcels

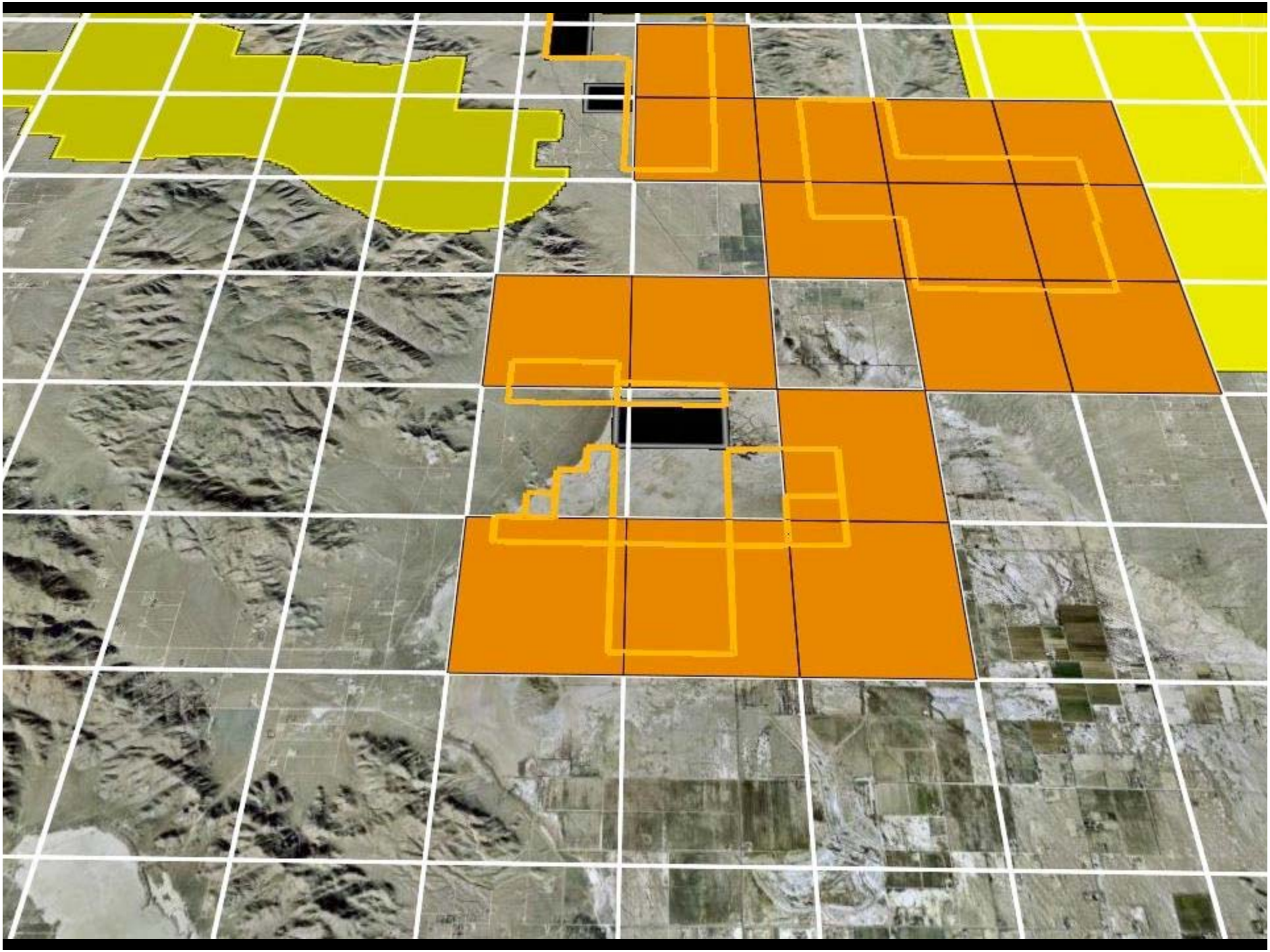
Out of State Projects

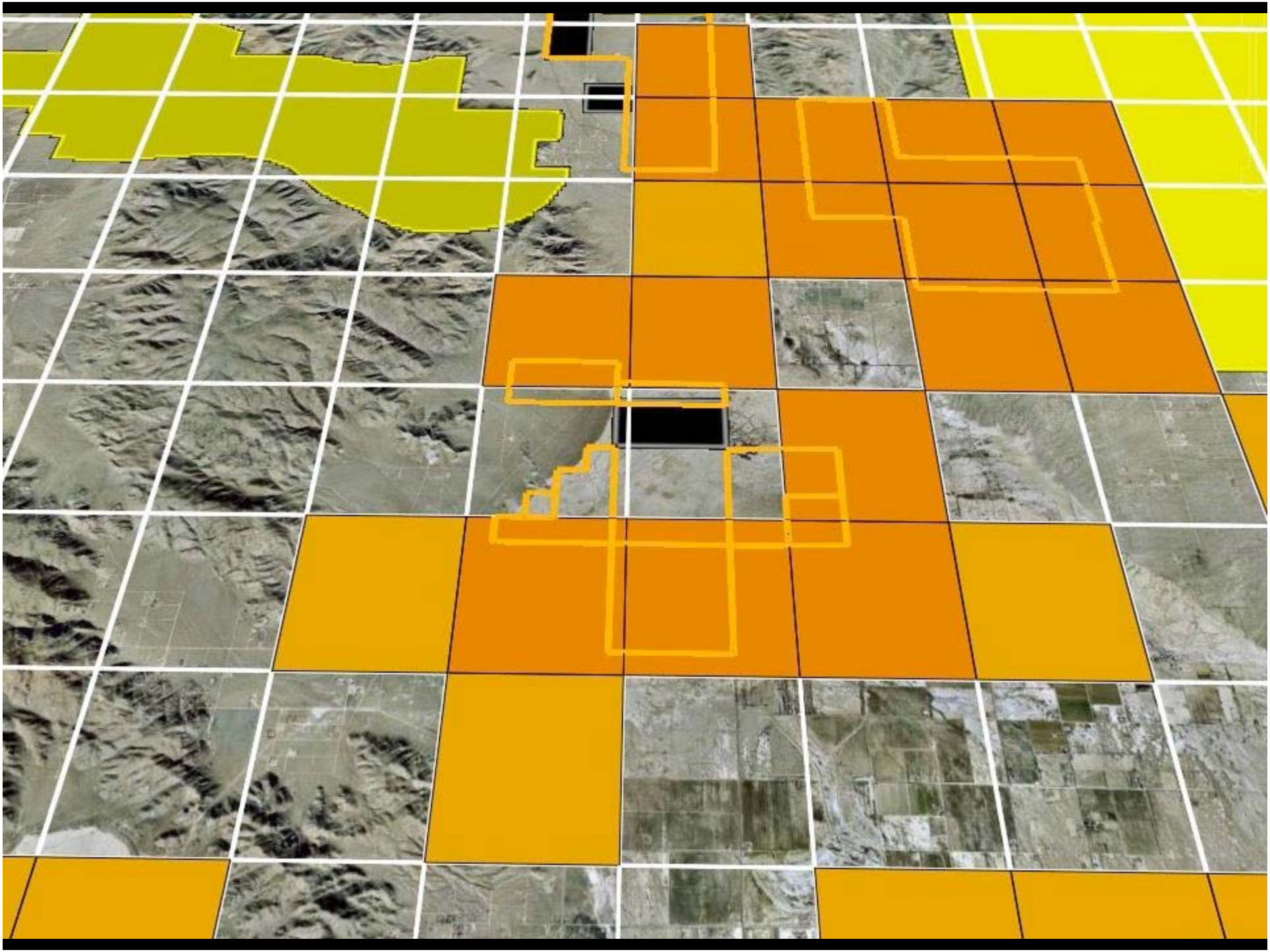
- Parcels with known commercial interest will be used to model projects in NV and AZ
- Import limitation is 2,500 MW in 2020











Project Identification and Characterization – Solar Thermal

All solar thermal projects will be modeled as a solar trough plant

- No thermal storage
- Dry cooled by default, wet cooled only with available recycled water

Capital Costs

Project capital cost may be adjusted for:

- Site topography which would result in increased earthmoving costs (slope dependent)
- Significant road construction required to access site
- Wet / dry cooling

Solar Thermal – Wet vs. Dry Cooling

- Cooling type based on availability of recycled water (treated municipal wastewater)
- If recycled water available, use wet cooling
  - ~40 plants in CA wet cooled
  - Assuming 14,000 in population provides enough waste water for one 200 MW plant
- All other plants assumed to be dry cooled

Project Identification and Characterization – Solar Thermal

Plant Performance

Performance characteristics calculated by model developed at NREL

- Capacity factor and production profile
- Insolation and meteorological data from satellite-derived data in the National Solar Radiation Database (NSRDB)
- Each project is simulated by a performance model run with inputs specific to project location

Project Identification and Characterization – Solar Thermal

Results

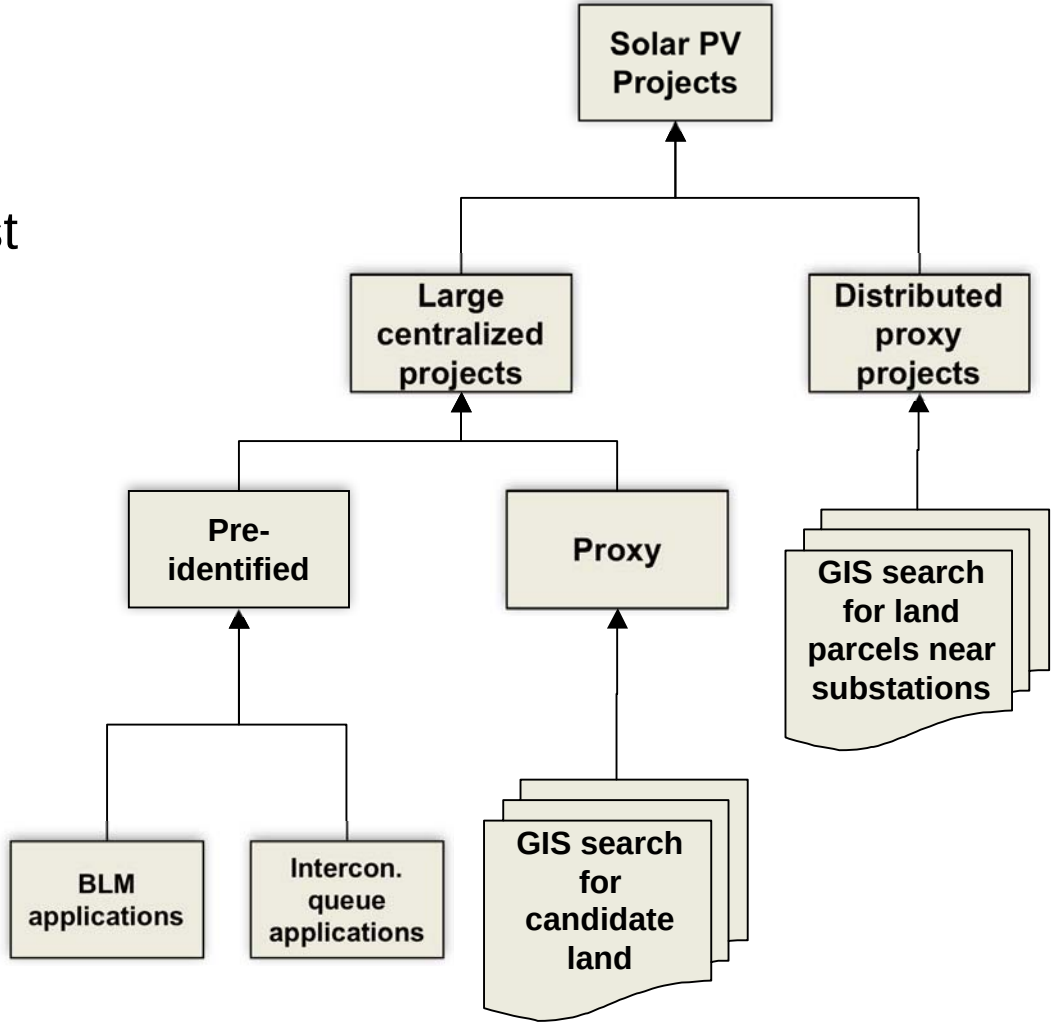
- California
  - 1,785 Projects
  - 357 GW of capacity
  - 790 TWh of generation
- Nevada and Arizona
  - 33 Projects areas;
  - 79 GW of capacity
  - 182 TWh of generation

- Cost of generation ranged from $133/MWh to $300/MWh, with $167/MWh average.

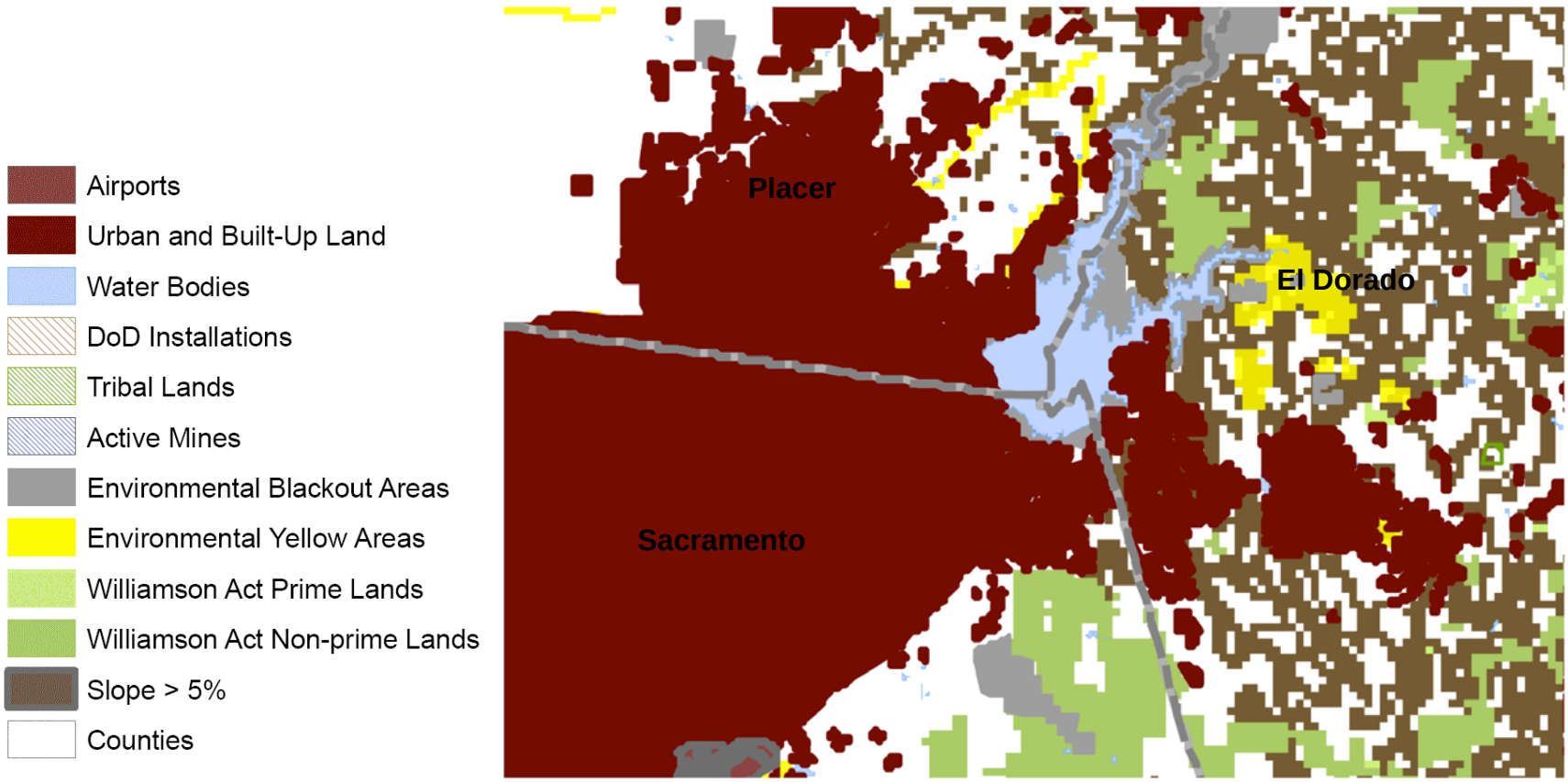
Solar Photovoltaic

Project Identification and Characterization Solar Photovoltaic

- Large centralized projects
  - Used land parcels from solar thermal project list for 150 MW projects
  - Included all BLM and pre-identified solar PV projects
- Distributed proxy projects
  - 20 MW projects near substations
  - Excluding environmentally sensitive areas



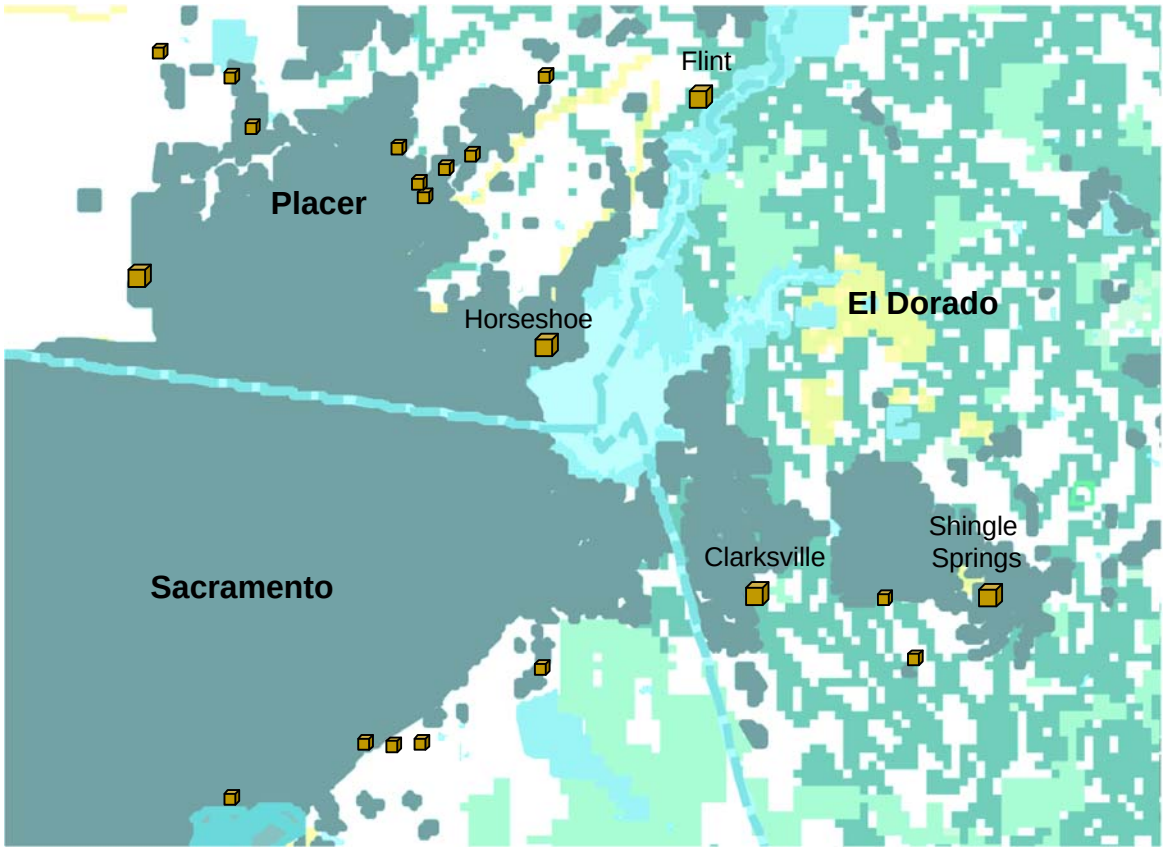
Solar Photovoltaic Exclusion Areas



Substations between 50 kV and 200 kV

- 138 kV substation
- 69 kV substation

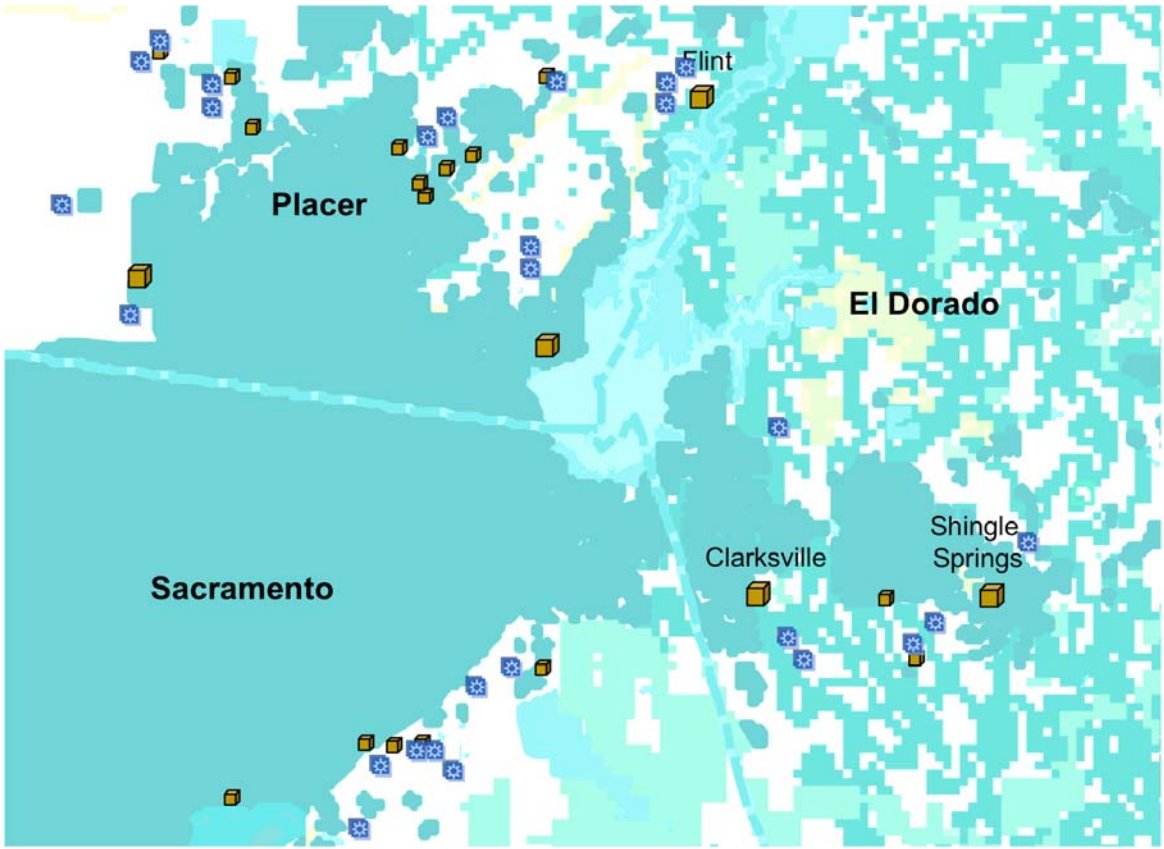
- Airports
- Urban and Built-Up Land
- Water Bodies
- DoD Installations
- Tribal Lands
- Active Mines
- Environmental Blackout Areas
- Environmental Yellow Areas
- Williamson Act Prime Lands
- Williamson Act Non-prime Lands
- Slope > 5%
- Counties



20 MW Solar Photovoltaic Projects

- 20 MW solar PV proxy project
- 138 kV substation
- 69 kV substation

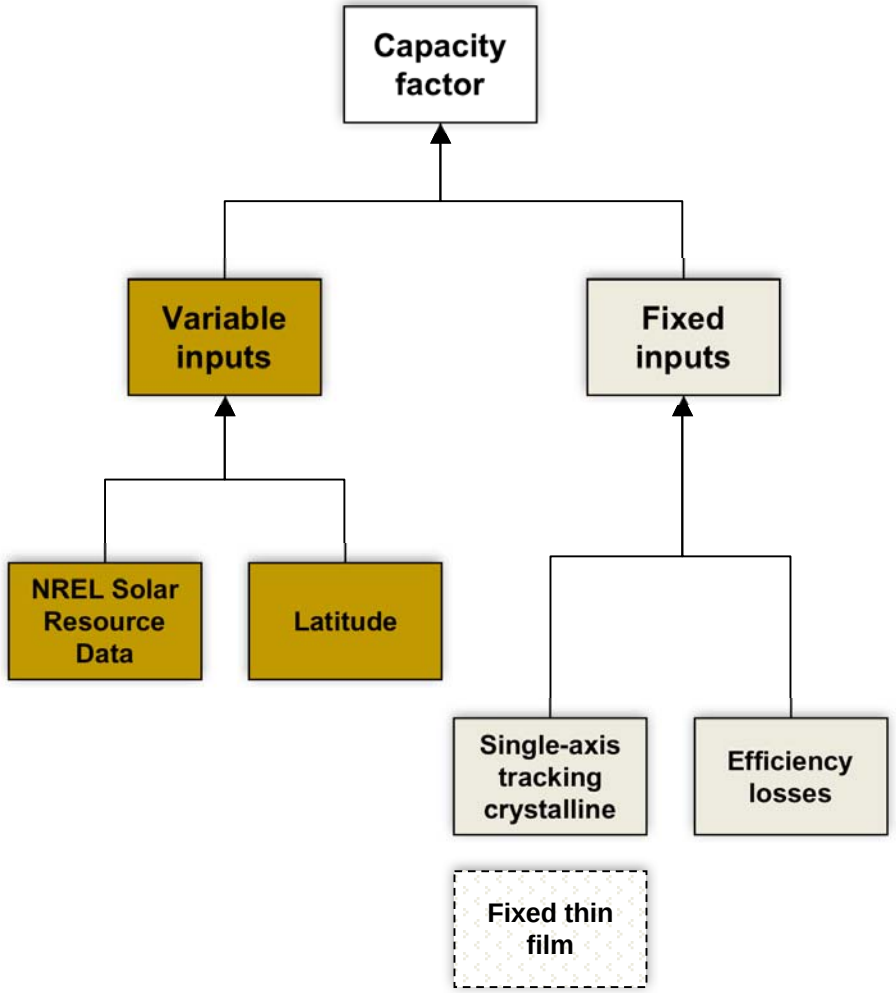
- Airports
- Urban and Built-Up Land
- Water Bodies
- DoD Installations
- Tribal Lands
- Active Mines
- Environmental Blackout Areas
- Environmental Yellow Areas
- Williamson Act Prime Lands
- Williamson Act Non-prime Lands
- Slope > 5%
- Counties



Project Identification and Characterization – Solar Photovoltaic

Capacity Factor

- Variable inputs
  - High resolution NREL GIS solar data with monthly averages
  - Latitude for determining path of the sun
- Fixed inputs
  - Technology assumption
    - Base case: Single axis tracking crystalline
    - Sensitivity case: Fixed thin film
  - Efficiency losses to include soiling, inverter, wiring and other loss mechanisms

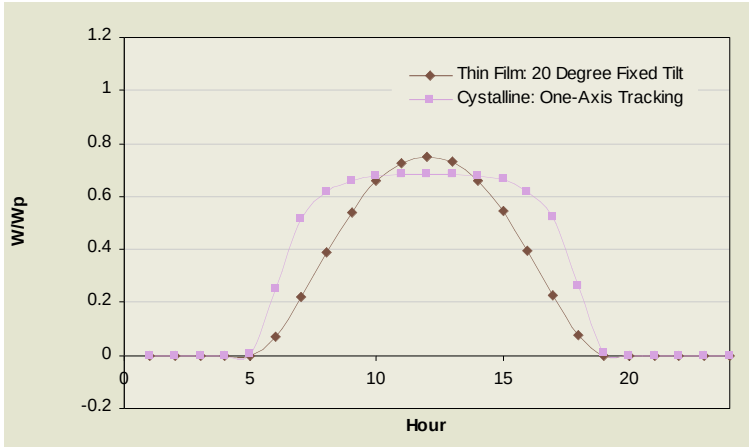


Project Identification and Characterization – Solar Photovoltaic

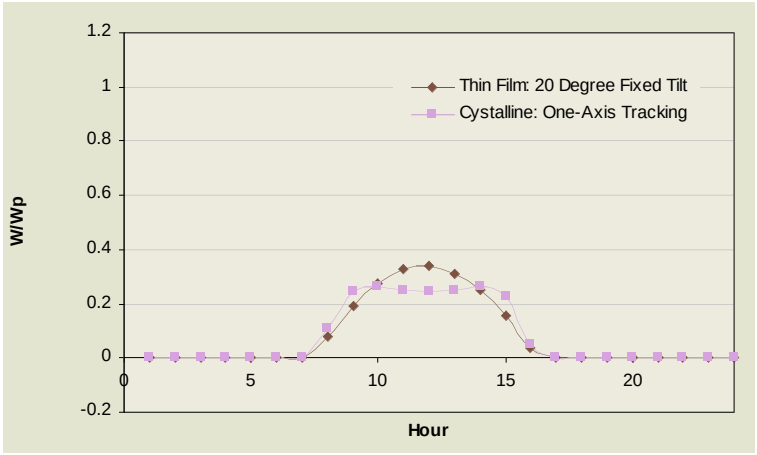
Production profile

- 12 x 24
  - Typical 24 hour production profile for each month
- Production profile variation drivers
  - Month of year
  - Latitude
  - Single axis vs. fixed tilt
  - Temperature

Example Energy Output from Crystalline Silicon and Thin Film (Jul)



Example Energy Output from Crystalline Silicon and Thin Film (Dec)



CONCEPTUAL – FOR EXAMPLE ONLY

Solar Photovoltaic Projects Summary

	Base Case Crystalline	**Sensitivity** Thin Film
Base Project Capital Cost ($/kWe)	7,000	3,700
Variable O&M ($/MWh)	N/A	N/A
Fixed O&M ($/kWe)	44	25
Levelized Cost of Energy ($/MWh)*	192 to 285	114 to 176

	# of projects	**Capacity (MW)**	**Generation (GWh/year)**
Distributed projects	1,375	27,500	58,775
Large projects	1,785	267,750	623,496

*Costs include gen-ties for small distributed projects. Not calculated yet for larger projects.

Wind

Wind Projects – Siting in California

Proxy Projects

- Based on available land not identified or connected with other project data
- Meet requirements for wind resource, terrain, environmental sensitivity, military restrictions, etc.
- Best projects selected first

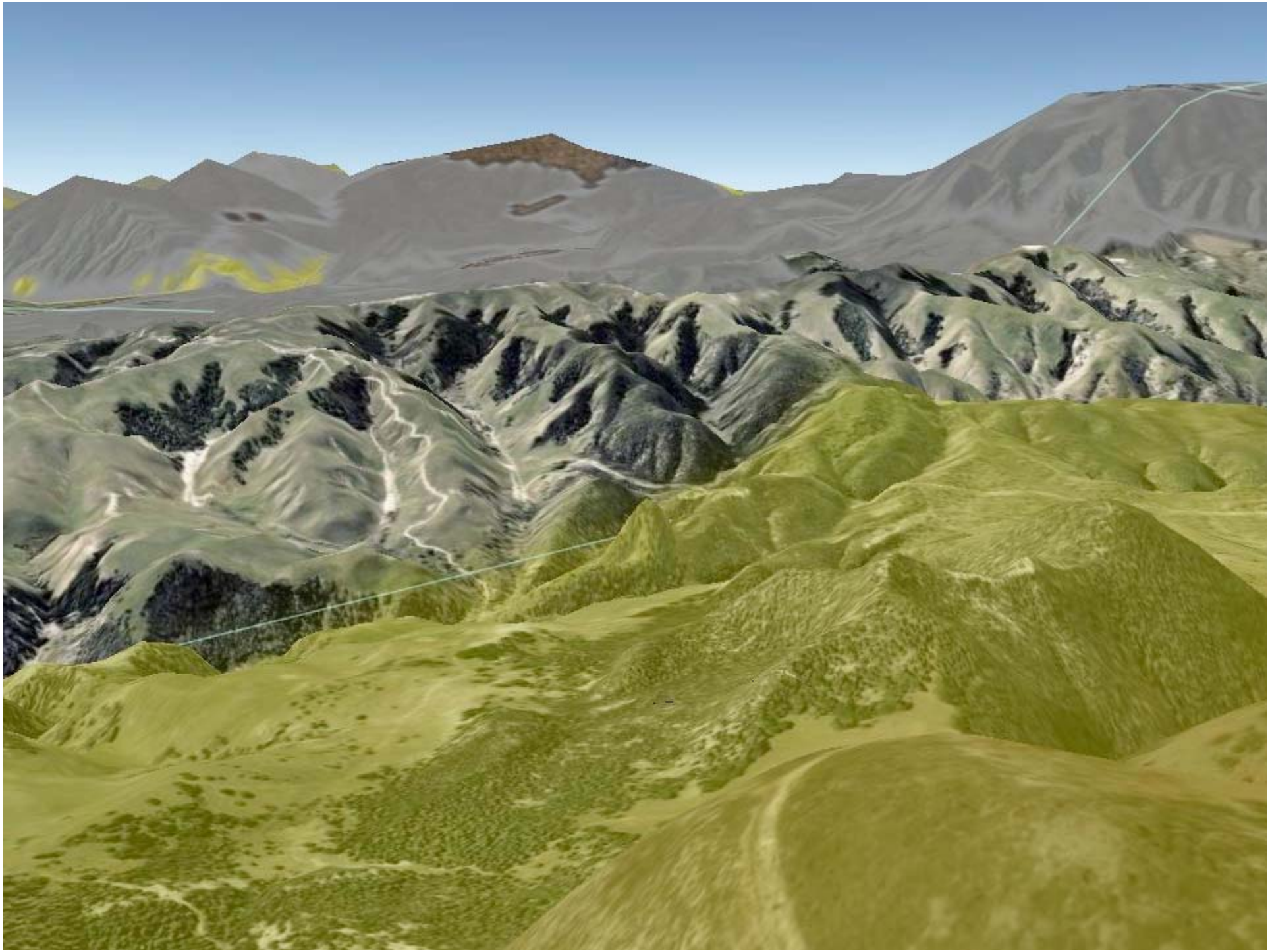
Pre-Identified Projects

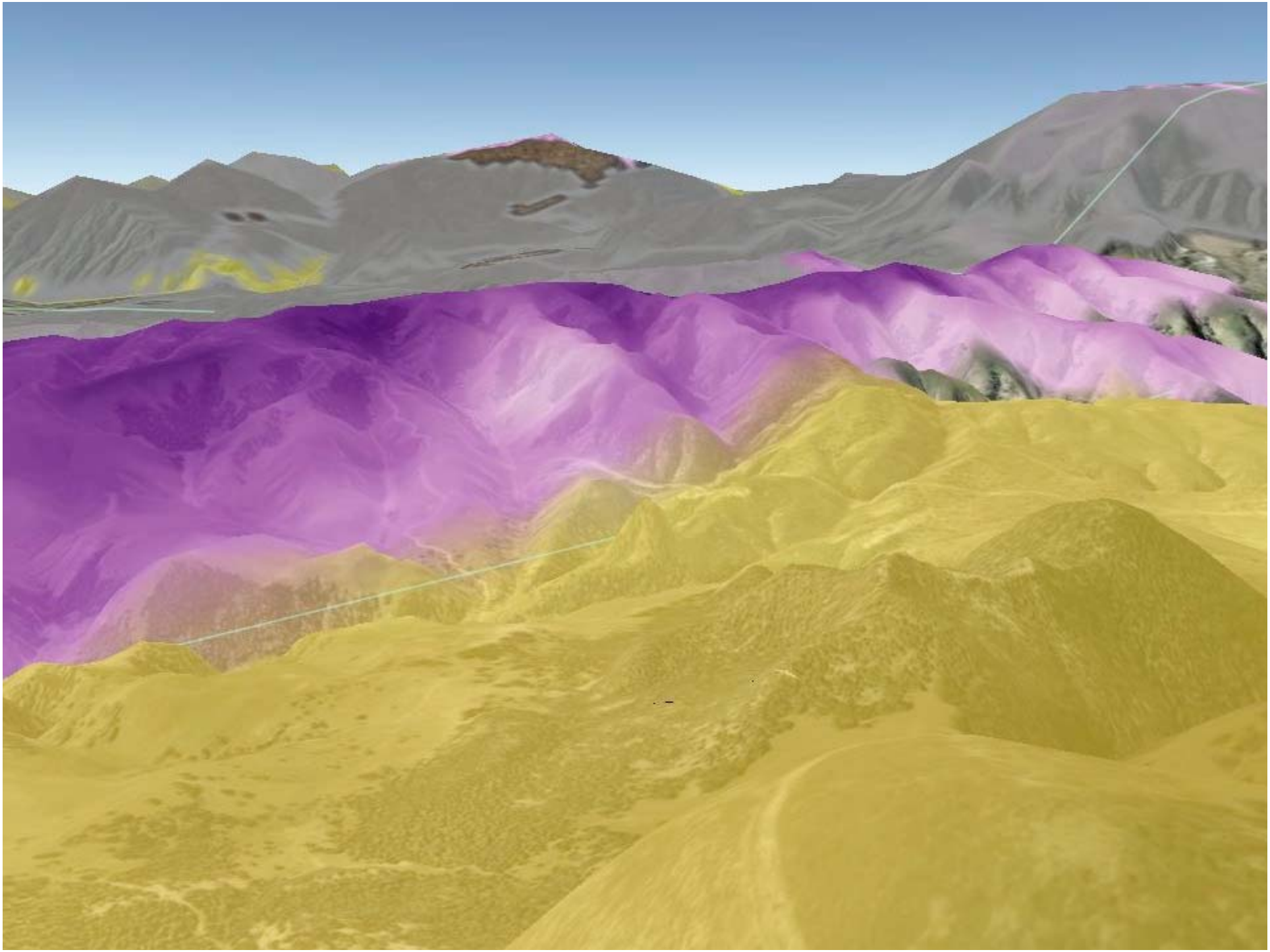
- Based on RFI data and BLM data.
- Can be sited in restricted areas (EWG Yellow, Military Red)

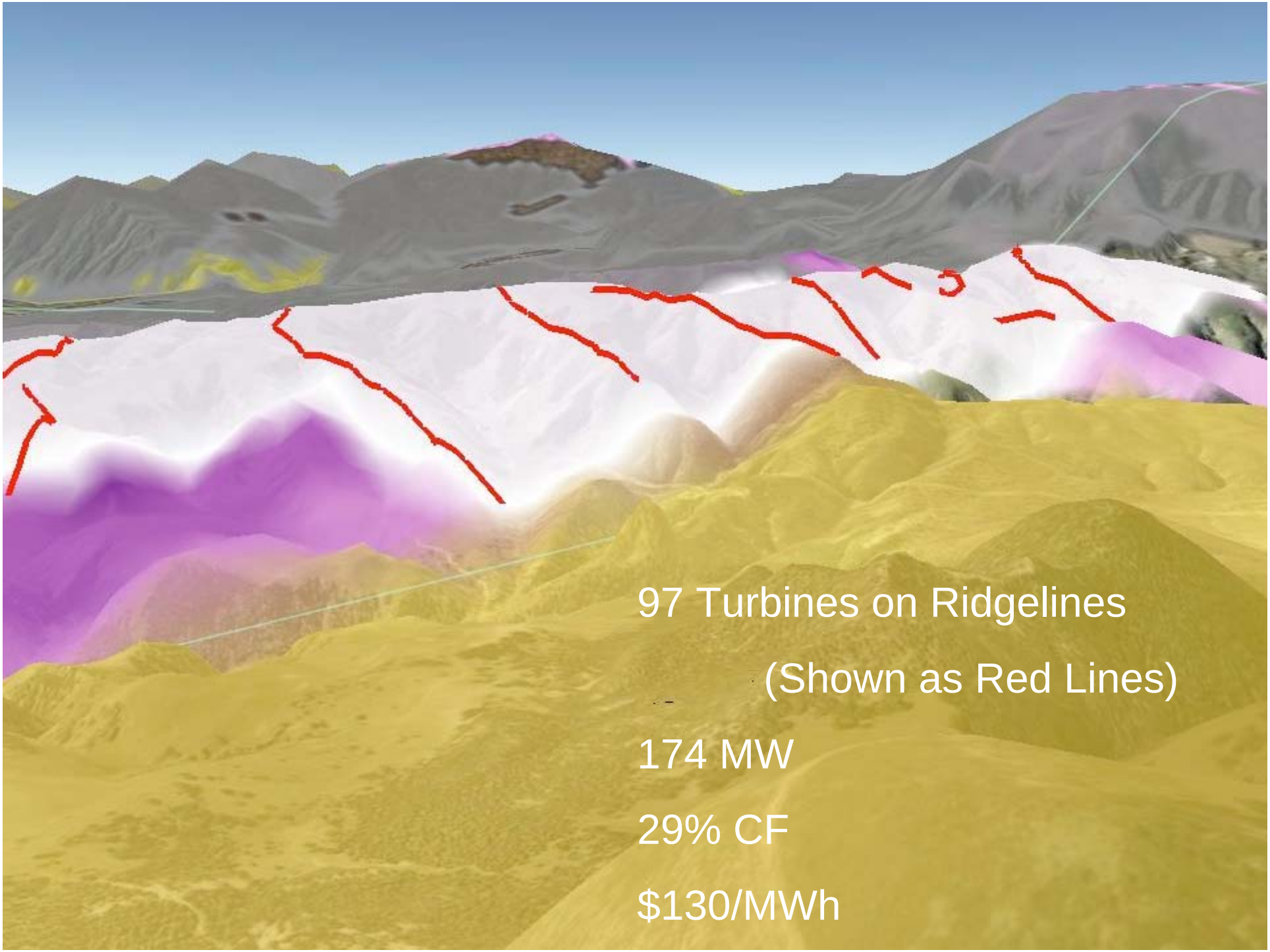
Wind Projects – Siting

Out of State Projects

- Oregon, Washington and Baja California Norte projects were modeled using GIS data, considering competing demand and a discount for “developability”
  - Only pre-identified projects in Southern Nevada were included
  - PG&E study data was used for British Columbia
  - Typical capacity factors, based on wind class, were used for out of state projects where no wind speed distribution data was available
- Subject to import limitations and resource competition






97 Turbines on Ridgelines
(Shown as Red Lines)
174 MW
29% CF
$130/MWh

Wind Projects - Characterization

Capital Costs

- Reference balance of plant construction costs developed for several types of project sites
  - Costs adjusted by type of terrain
- Wind turbine procurement costs assumed to be uniform for all project types
- Cost adjustment for distance of site from major roads and highways

Wind Projects - Characterization

Plant Performance

Performance characteristics based on the California wind speed map

- Capacity determined by amount of land (sq. mi.) available at each wind speed
  - Turbine spacing is a function of NREL wind class, slope
  - For mountainous projects, ridgelines that were perpendicular to the prevailing wind direction were identified and a linear turbine spacing was used
- Capacity factor was calculated based on Weibull shape and scale parameters
  - A gross to net capacity factor 12% loss factor was applied to all projects

Wind - Results

In State

- 131 projects totaling 16,127 MW
  - Expected to produce 46,298 GWh of electricity annually
  - 62 pre-identified projects – representing 8,345 MW
  - 69 proxy projects – representing 7,782 MW
- Capital costs ranged from $2,260 - $2,680 / kW
  - Average capital cost was $2,500 / kW
  - Higher than identified in Phase 1A, due to recent cost increases
- Capacity factors ranged from 26 to 44 percent – average of 32 percent
- LCOE values ranged from $63 to $145 / MWh – average of $108 / MWh

Wind - Results

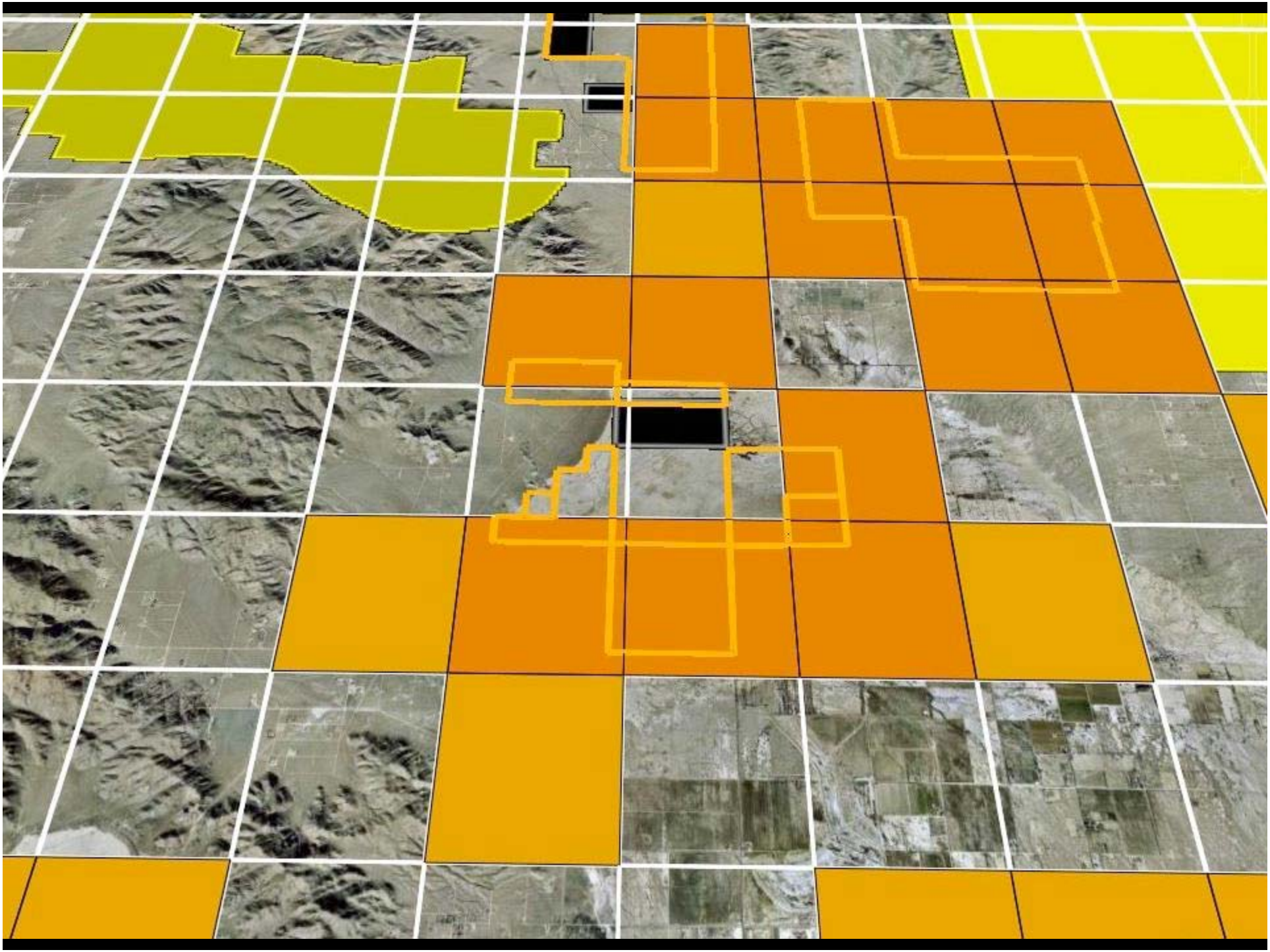
Out of State

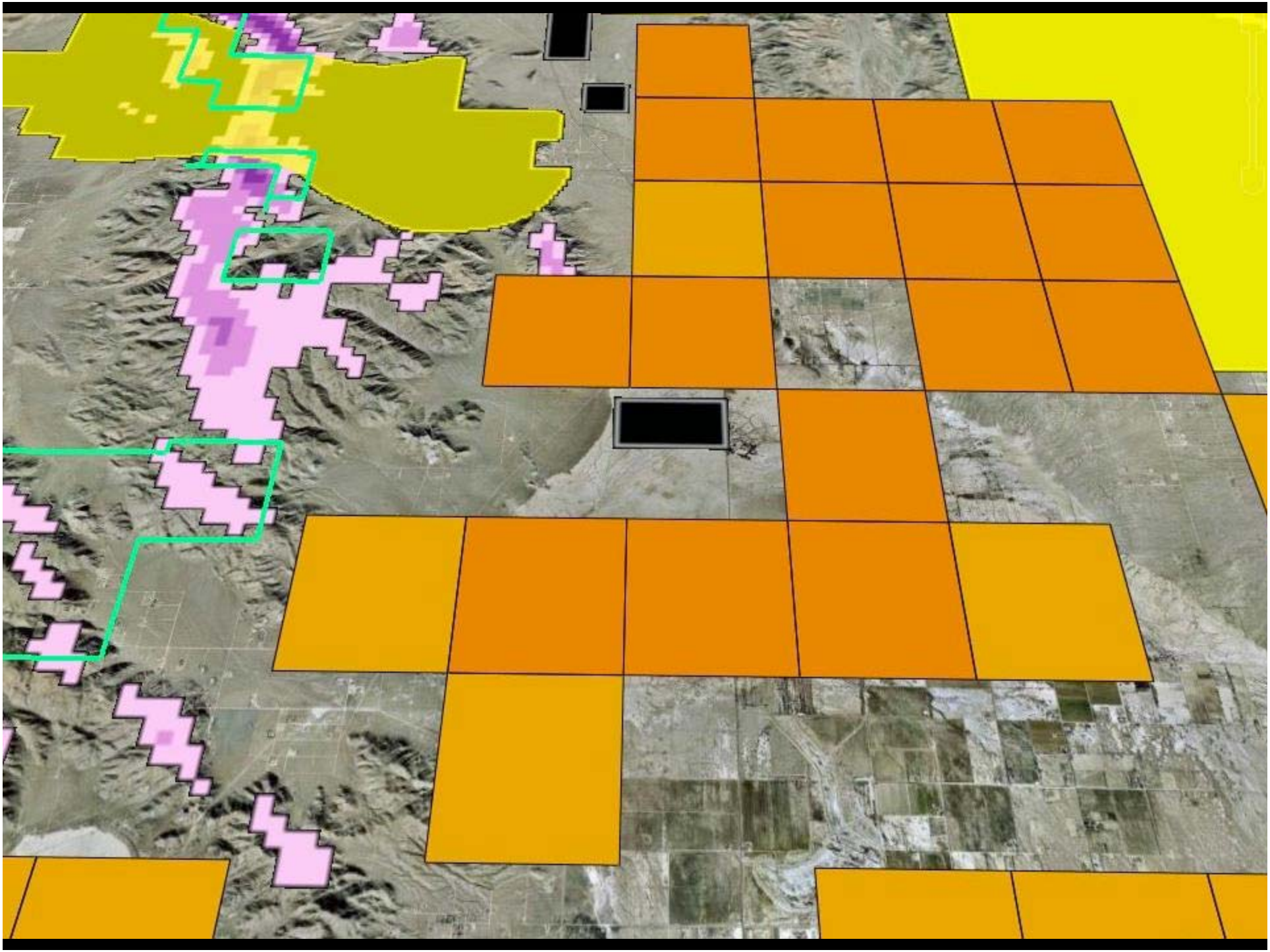
- 46,190 MW of out of state resources identified
  - Expected to produce 112,694 GWh of electricity annually

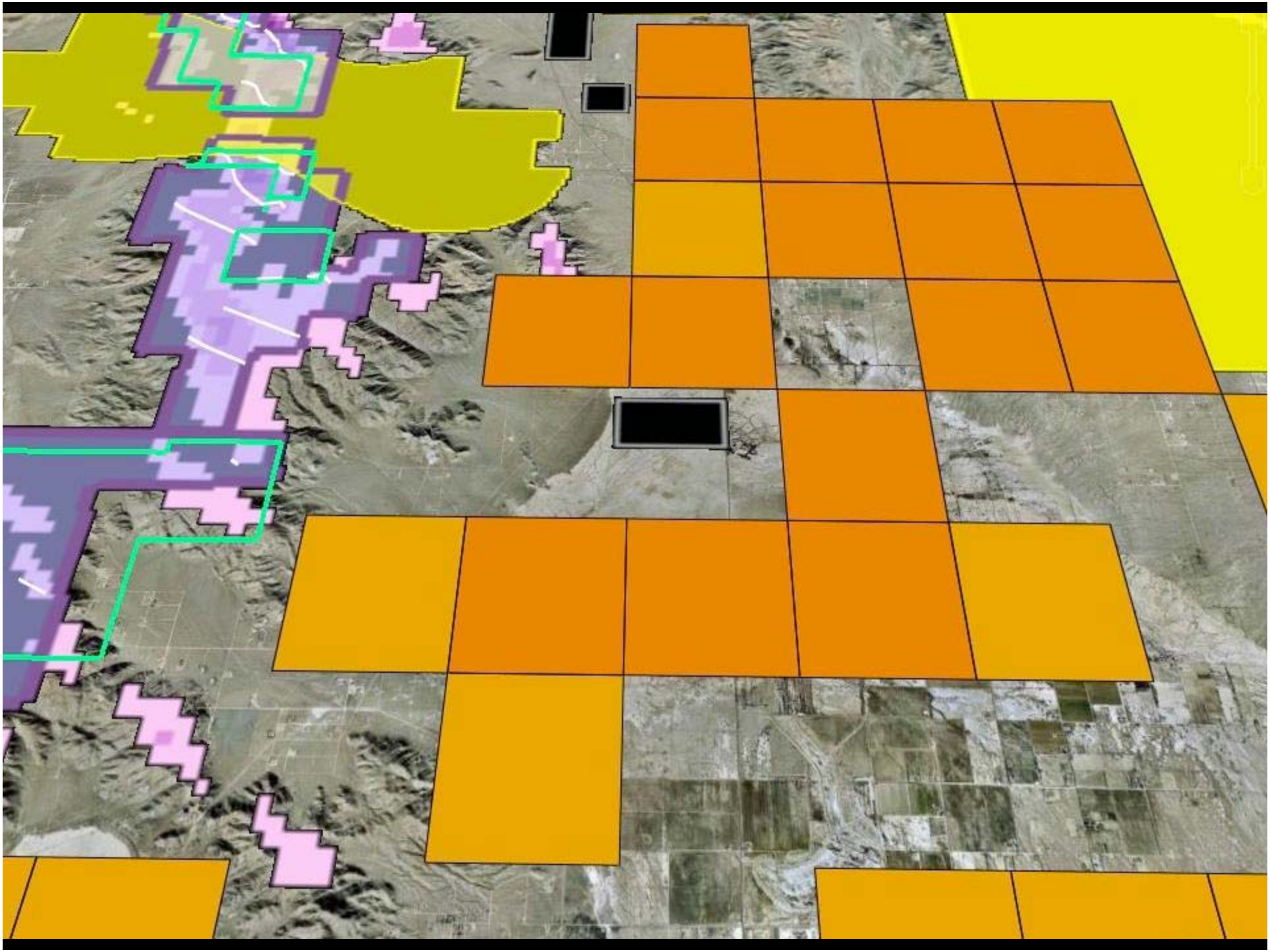
Out of State Resources		
Region	**Capacity (MW)**	**Energy (GWh)**
Nevada	1,475	3,203
Baja California Norte	2,773	8,014
Oregon	18,766	41,353
Washington	15,046	34,921
British Columbia	8,130	25,203

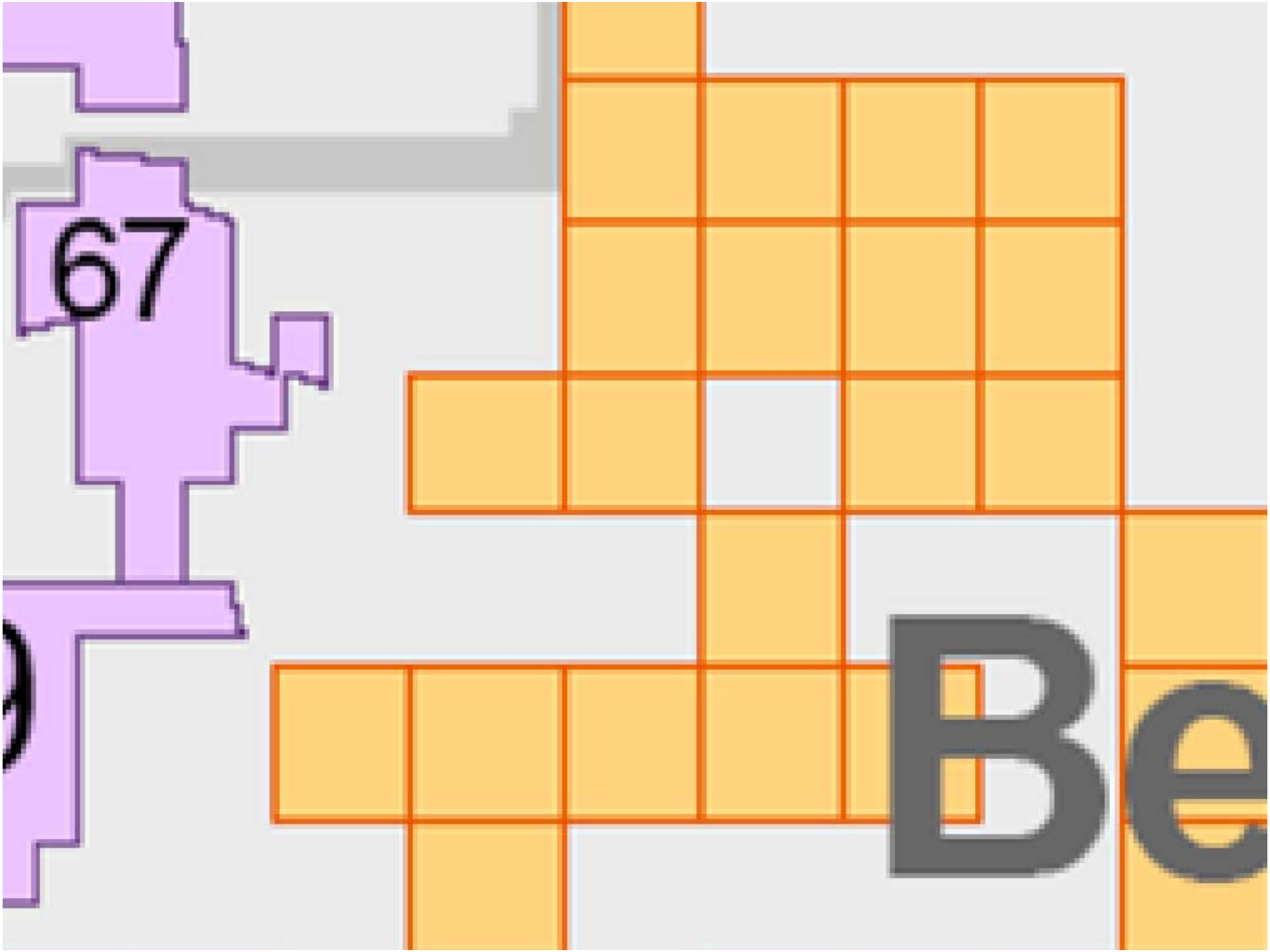
These amounts do not include import restrictions due to transmission or resource competition

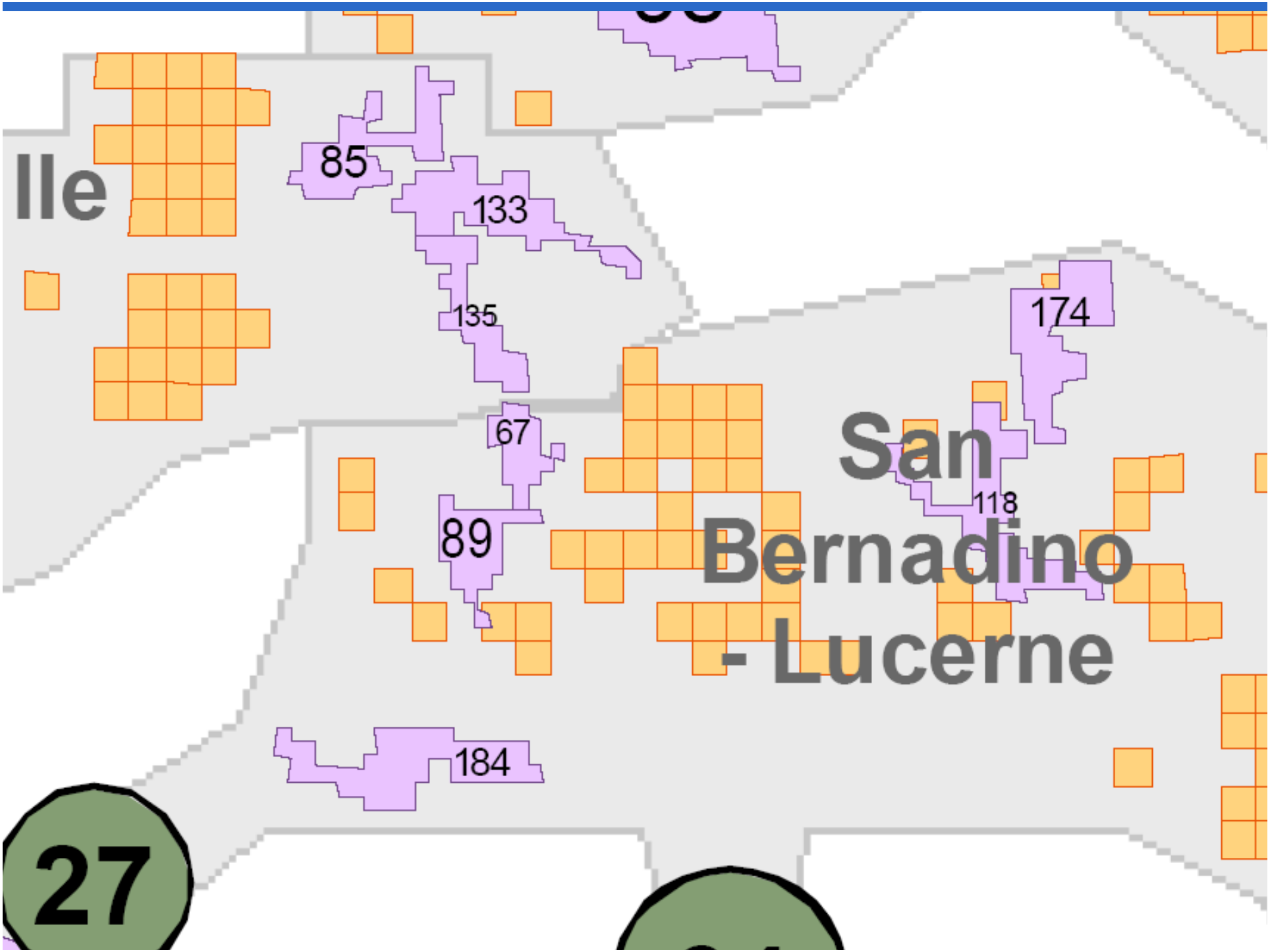
CREZ Identification

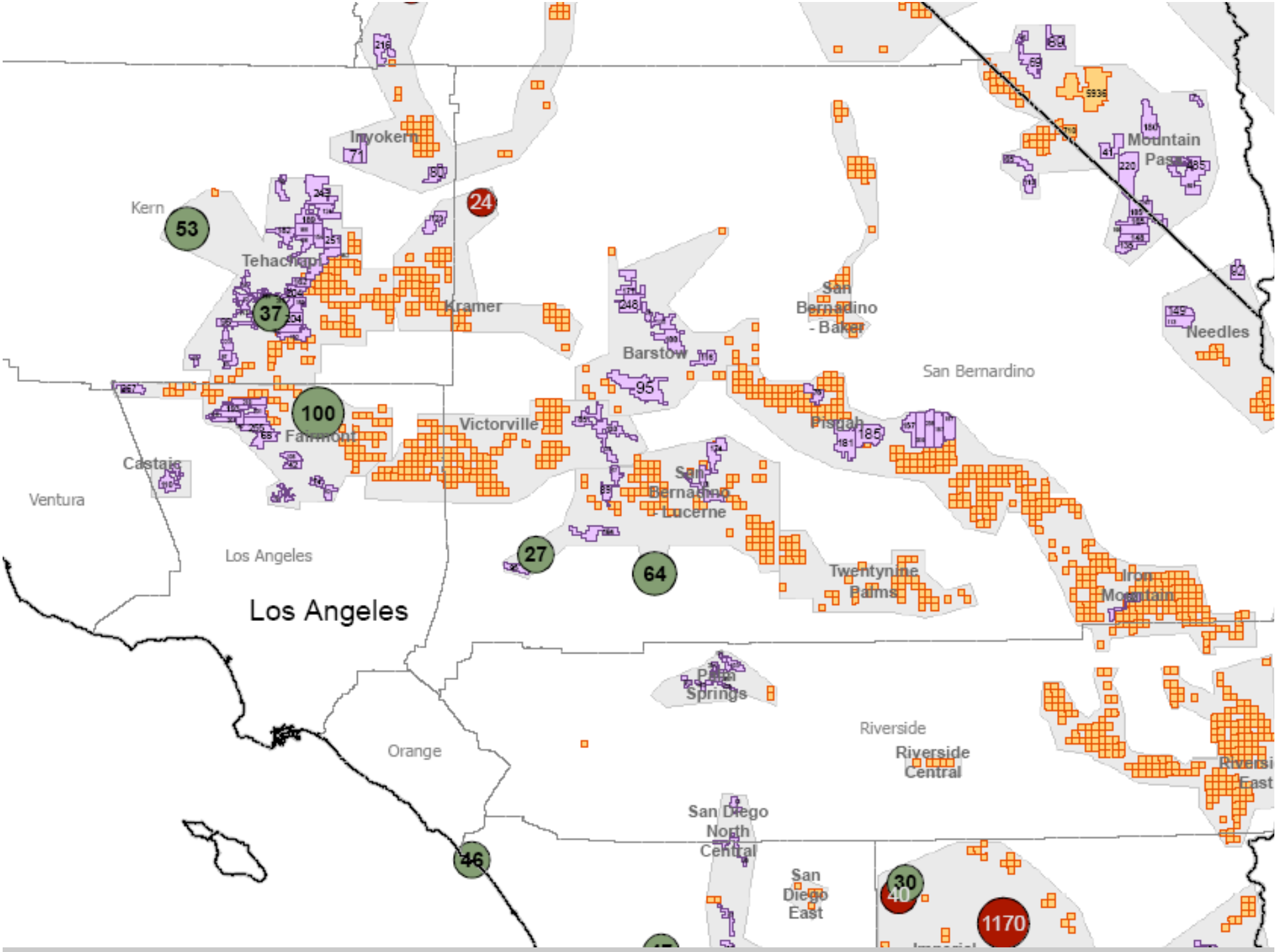






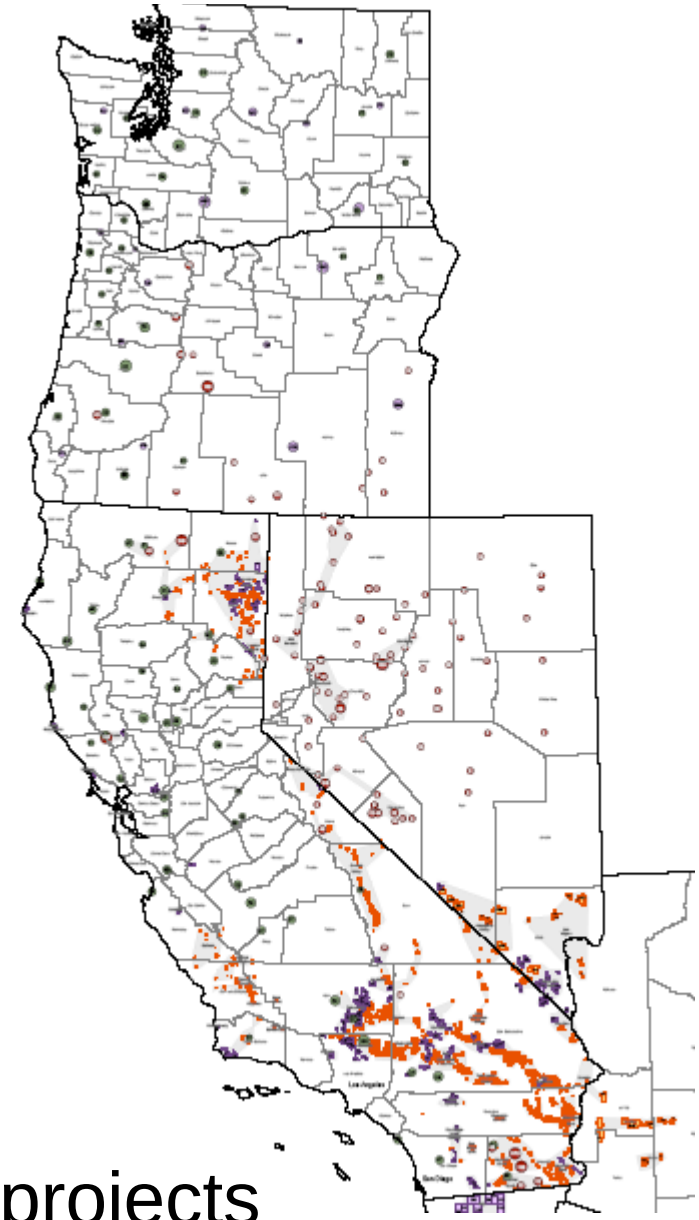

67
Be


lle
85
133
135
174
67
San
118
89
Bernadino
- Lucerne
184
27


Kern
Inyokern
Tehachapi
Kramer
Barstow
Victorville
Fairmont
Castaic
Ventura
Los Angeles
Los Angeles
Orange
San Bernardino
San Bernardino - Baker
Mountain Pass
Needles
Pisgah
San Bernardino - Lucerne
Twentynine Palms
Iron Mountain
Palm Springs
Riverside
Riverside Central
Riverside East
San Diego North Central
San Diego East
53
24
37
100
95
185
27
64
46
30
40
1170

CREZ Identification

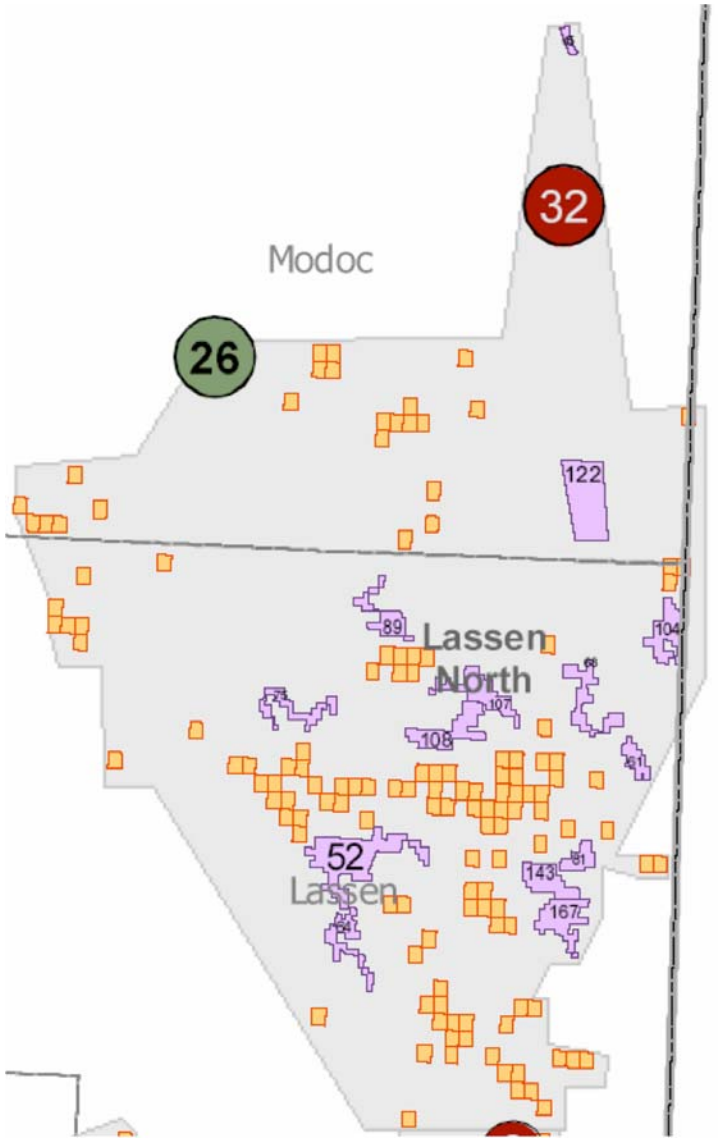
- CREZs identified by
  - Similar geography
  - Similar transmission solutions
- 58 CREZs Identified
  - 47 California
  - 11 Out-of-state
- Also, many smaller, non-CREZ projects



- Each CREZ is like a holiday present…

- The size of the box is less important than the nature of its contents

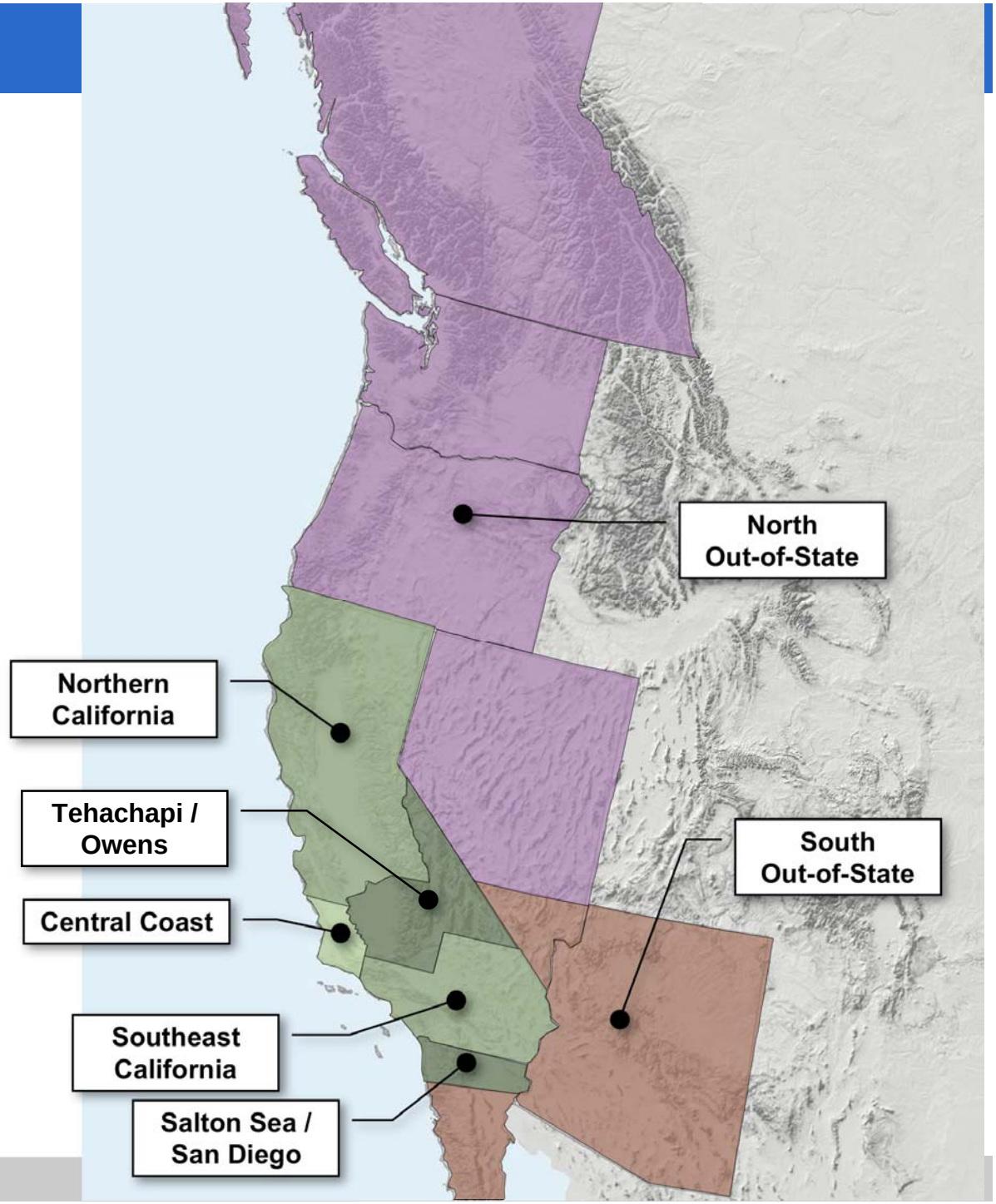
A CREZ's Size is Not Proportional to its Value



Lassen North CREZ

- Capacity **28,237 MW**
  - Solar Thermal 27,000 MW
  - Wind 1,179 MW
  - Biomass 26 MW
  - Geothermal 32 MW

Summary By Generic Resource Regions



Capacity (MW) Summary by Resource Region

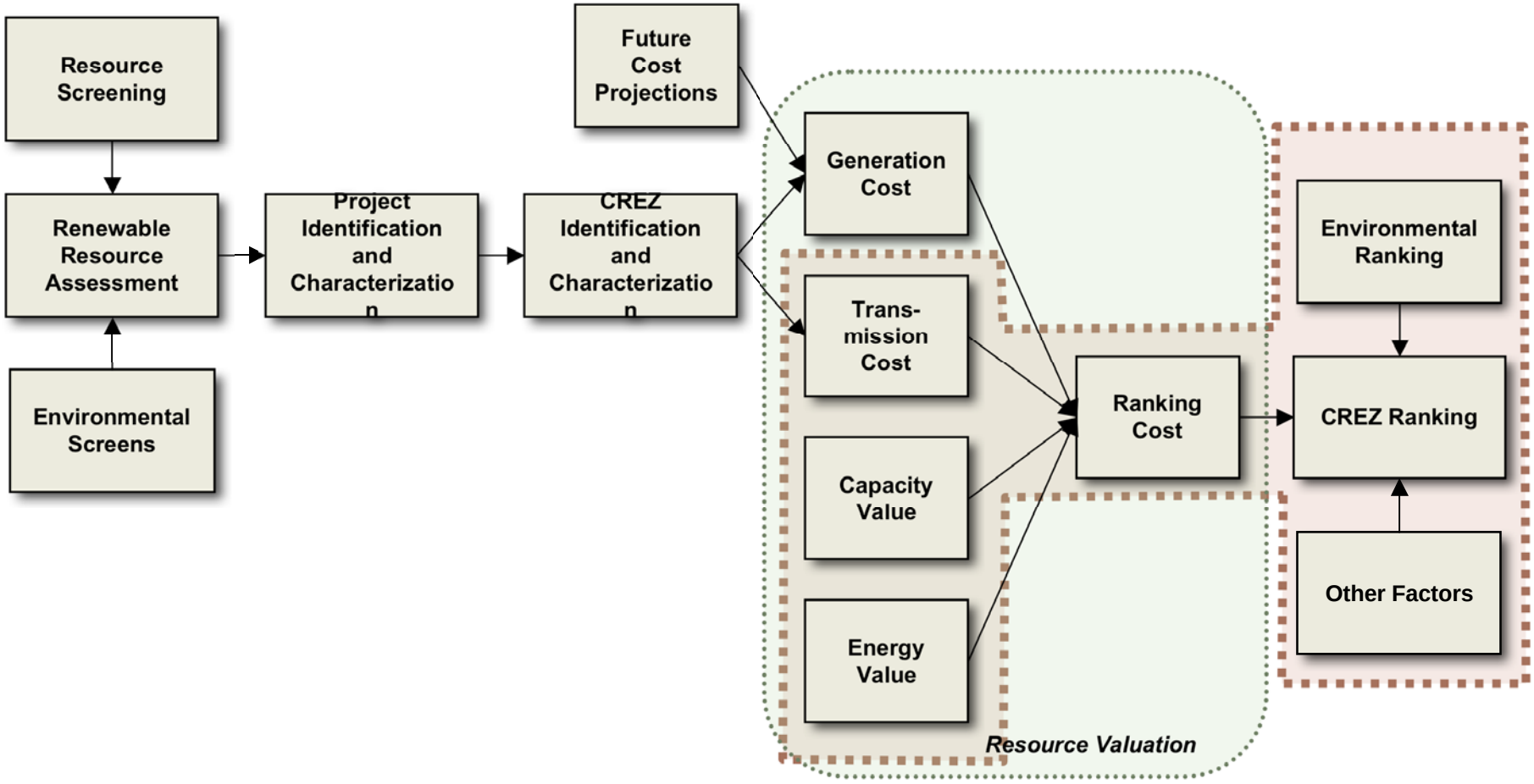
	Biomass	Geo-thermal	Solar PV	Solar Thermal	Wind	Total
Central Coast	23		920	16,200	552	17,695
North Out-of State*	2,423	2,199		2,400	41,982	49,003
Northern California	1,150	468	16,480	40,200	3,341	61,639
South Out-of-State*			40	44,679	2,773	47,492
Salton Sea / San Diego	159	1,434	1,640	35,000	1,128	39,361
Southeast California	91		4,020	223,245	6,807	234,163
Tehachapi/Owens	302	72	4,400	74,000	5,721	84,495
Total	**4,148**	**4,173**	**27,500****	**435,724**	**62,304**	**533,848**

*Out-of-state resources not constrained by transmission import limitations or resource competition

**Solar PV does not include large 150 MW PV projects totaling 267,750 MW. Also does not include small CSI.

Next Steps

Next Steps


Resource Screening
Renewable Resource Assessment
Environmental Screens
Project Identification and Characterization
CREZ Identification and Characterization
Future Cost Projections
Generation Cost
Trans-mission Cost
Capacity Value
Energy Value
Ranking Cost
Resource Valuation
Environmental Ranking
CREZ Ranking
Other Factors

Next Steps: Resource Definition & Modeling

- Known Project List Incomplete
  - BLM provided new list of projects to RETI on August 13.
  - GIS data not yet available from BLM
  - These will be included in the CREZ analysis
- Comments on identified resources sought by August 27

Next Steps: Resource Valuation & Supply Curves

Ranking Cost = Costs – Value

Generation Cost
+ Transmission Cost

—

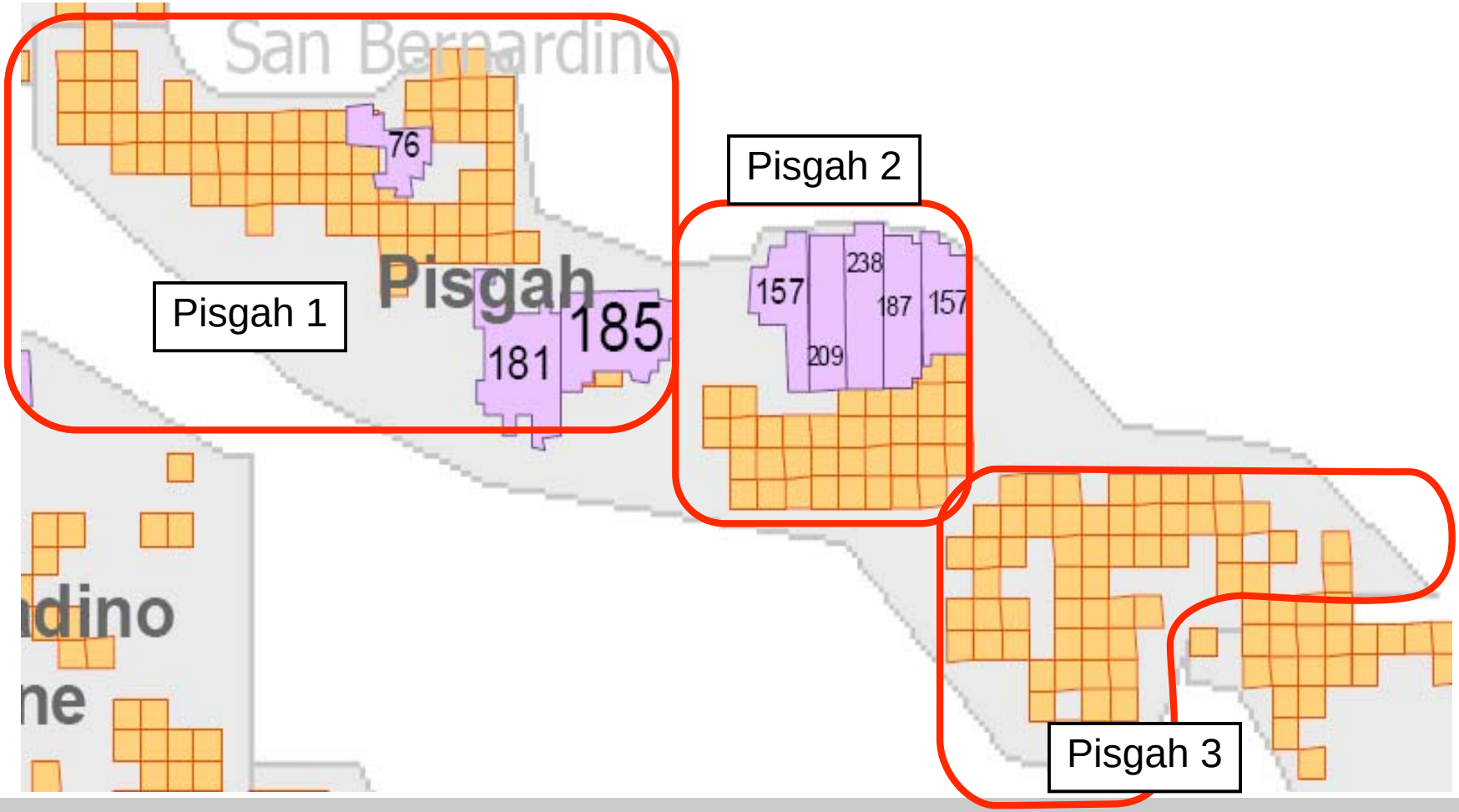
Energy Value
+ Capacity Value

- Generation Cost: Complete
- Transmission: Define sub-CREZ's based on transmission timing and resource economics
- Energy Value: Ventyx-modeled marginal costs based on CEC 2007 IEPR Analysis
- Capacity Value: Average capacity during system peak periods

Next Steps: CREZ & Sub-CREZ Design

- CREZ – 58 Defined. Review-adjust after project definition completed.
- Develop sub-CREZs based on:
  - Resource economics
  - Transmission development
  - Timing

CREZ Example: Pisgah CREZ and sub-CREZ

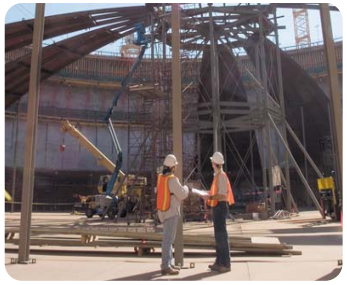


Next Steps: Uncertainty Analysis

- Model alternative assumptions to test range of possible scenarios
  - Thin Film Solar PV
  - Resource characteristics (capital cost, capacity factor, etc.)
  - Energy value
  - Transmission cost
  - Tax Credits

BUILDING A WORLD OF DIFFERENCE®

BLACK & VEATCH





Thank You!

Ryan Pletka
pletkarj@bv.com
Tel: 925-949-5929

Ric O'Connell
oconnellrm@bv.com
Tel: 925-949-5914

Tim Mason
masont@bv.com
Tel: 925-949-5943